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FOREWORD.

The lectures which constitute this, the Fifth Annual Volume of Popular Science Talks, represent the effort of the Philadelphia College of Pharmacy and Science to contribute to the educational welfare of the community at large by means of popular scientific discussions.

The public for whom these lectures were primarily intended has shown its appreciation of them by continued patronage of the lectures themselves, and by the increased sales of the volumes of the lectures.

As will be noted by a survey of the list of subjects, there is no interdependence between them and they are not arranged in any definite order.

It has always been the practice to permit each lecturer to select some subject from the broad field of science, which is primarily of interest to the public and which is capable of being presented in an easily understandable form without any sacrifice of scientific accuracy or completeness. It is customary to illustrate the lectures appropriately by means of specimens, experiments, lantern slides, etc.

The new series arranged for this year, a list of which appears at the end of this volume, will be found to include an entirely different list of subjects from that of any previous season.

PAPER

By Henry Leffmann, A. M., M. D.

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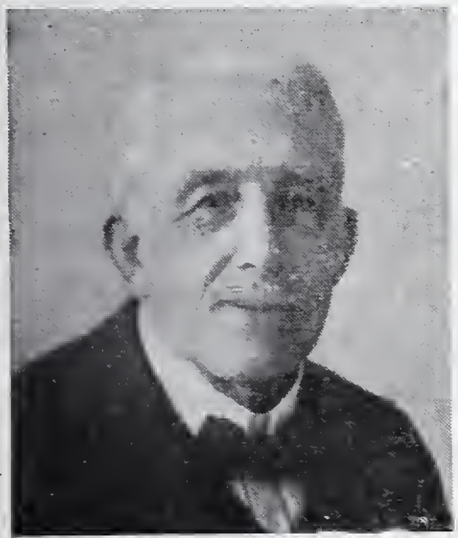
DE QUINCEY suggested that the failure of the ancient nations, that had considerable development in civilization, to invent the art of printing was due to lack of a cheap and durable material upon which to make the impression. Attention has been called to the fact that the use of movable type was essentially the same as the use of the dies for striking coins and medals, and that the possibility of using a similar method for duplicating language would be almost sure to suggest itself. The work of the Egyptians, Greeks and Romans has been long before the world, but that of the nations of the Mesopotamian regions is of comparatively recent discovery, at least, so far as the ability to read the inscriptions. Fortunately, these records were on an imperishable material (clay.) and an immense amount of most valuable history has been obtained in the last quarter-century through the excavations in those regions. Some have supposed that the forms for each letter were prepared somewhat similar to the type of the present day, but it seems more likely that a simple stylus was used, each letter form being made by the necessary succession of incisions.



Henry Leffmann, A. M., M. D.

THE FIRST STENOGRAPHERS

It is probable that the failure of ancient nations to develop a definite system of printing was due to several causes. There was but a limited demand for books. The odes of Horace, for example, though doubtless very popular, found but a limited class of readers. Most of the people were illiterate. For many who cared to hear the poems a public reading would suffice. In this way many hundreds could be reached. The limited group that had libraries and wanted to possess copies of any work could be supplied by transcriptions at the hands of scriveners. Many of the slaves in Greece and Rome were fairly educated; an author could dictate to a group of these and thus a considerable number of copies could be issued quickly if the text was not extended.

Another reason for the failure of development of many mechanical arts was the lack of co-operation between the intellectual class (the philosophers) and the artisans. In the modern days, when such co-operation is so extended we can hardly appreciate the gap that existed between those who labored in the workshops and mines and those who studied and speculated in the schools.

ORIGIN OF WORD PAPER

Our word "paper" comes from the Greek "papyrus," the name of an aquatic plant belonging to the Sedges, a group allied to the grasses but not identical with them. The particular plant is known to botanists as the *Cyperus papyrus*. The Egyptian name was "bublos," the Greek form being a corruption of this. A further change was into the Greek word "biblion," coming finally to mean "book" and finding its resting place in modern language as "Bible" from a Greek plural form *"ta biblia,"* meaning "the books."

The papyrus plant grew abundantly in Egypt, the stalk being triangular as often the case in sedges. The top was crowned with a bushy collection of leaves. The method of preparing the papyrus is known. It was rather simple mechanically, but many grades were made from it. Slices of the stem were laid crosswise and made to adhere by a glutinous substance in the tissue. Some improvement in manufacture was made in course of centuries but the material was always rather frail and many valuable works have been lost through its perishability.

Far more permanence belongs to the other material which was used in early times, namely, parchment. The source of this is well known and need not be described here. Many of our most valuable records of the literature, history and philosophy of ancient times have come down in the form of parchments. A great deal of patience and skill was given during the early Christian centuries to the writing and ornamenting of parchment copies of the Bible and other writings under religious auspices. The earlier MSS, such as the two great codexes of the Bible, the Vatican and the Sinaitic, are all in capital letters termed ("uncials") and without divisions between the words. Later productions use a script text and are known as "cursives." The scarcity of good parchment frequently caused the scriveners to erase the text of some sheet and write another text. These are known as "palimpsests" from two Greek words meaning "to rub again." The erasures are often imperfect and it is possible to read most of the original writing, which is not infrequently the most

valuable at the present day. Thus, a well-known MS of a portion of the New Testament has been found as the original of a writing concerning a saint of the church. The deciphering of the under characters in such MSS has been of late facilitated by photographing under special conditions of light.

As to what exactly constitutes a true "paper" there is some dispute among experts, but it is not necessary to enter upon that here. At the present time we understand by the term a material suitable for printing or writing, which is essentially cellulose, that is, the basic material of plant cells. This is found in fairly pure form in cotton and linen, and hence the earliest forms of paper were made from them. Cotton is the filamentous material developed on the seeds of certain plants of the mallow family. Linen is the fiber of a plant commonly called "flax" and yielding the "linseed." Either of these materials beaten so as to soften and entangle them will give a serviceable sheet than can be obtained in thin layers and when dried will receive satisfactorily either printing or common ink.

THE FIRST PAPER

While the date at which the manufacture of paper was begun is uncertain, it seems proved that the Chinese were the first to carry it out successfully and that they had it in use nearly two thousand years ago. The Chinese used several different plants as the source of paper. Knowledge of the methods of making paper extended into the regions controlled by the Saracens about the beginning of the eighth century. Through their conquests in Spain the art was carried into Europe, and about the time of the first Crusade the Christians of Spain substituted rags for the plant fibers and over one hundred years later the method of stamping the rags in water enabled the production of an excellent material.

It is not necessary to trace the development of the paper industry through all its details. The papers made several centuries ago are noted for their keeping qualities while a large proportion of our modern paper is so perishable that there is much alarm as to the permanence of our contemporary records. The reason for this will appear later.

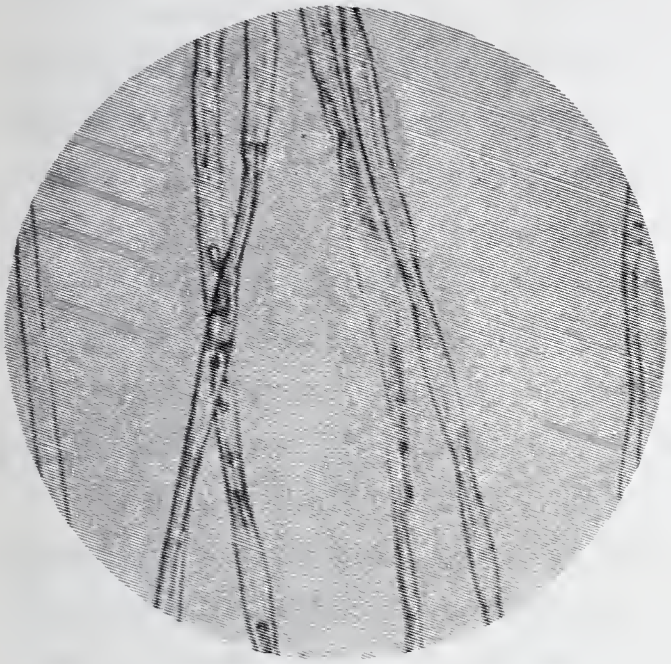
The uses of paper increasing rapidly, the manufacture of it became a widespread industry in progressive nations of Europe and from thence to the American Colonies. Philadelphia, which has been distinguished by so many "firsts," has the honor of having the first paper mill in America, established in what is now a part of the

incorporated city, although at the time of building of the mill it was in the suburbs. William Rettinghuysen, an emigrant from Holland, established the first paper in America, on the banks of a small stream, in the district known as Roxboro. The stream has an Indian name, but is usually called "Paper-mill Run." The location of the mill is now marked by a tablet, and is within the bounds of Fairmount Park. Rittenhuysen modified his name to "Rittenhouse," and his great grandson, David, became famous as a scientist. The district in which the first mill was built was eminently suitable for such work, being in the deep valley of Wissahiccon creek, with considerable fall from the source to the mouth, permitting thus the erection of dams at frequent intervals. The rocks of the creek are mostly granitic in nature, yielding but little soluble or suspended matter at ordinary times and hence both power and clear water were available.

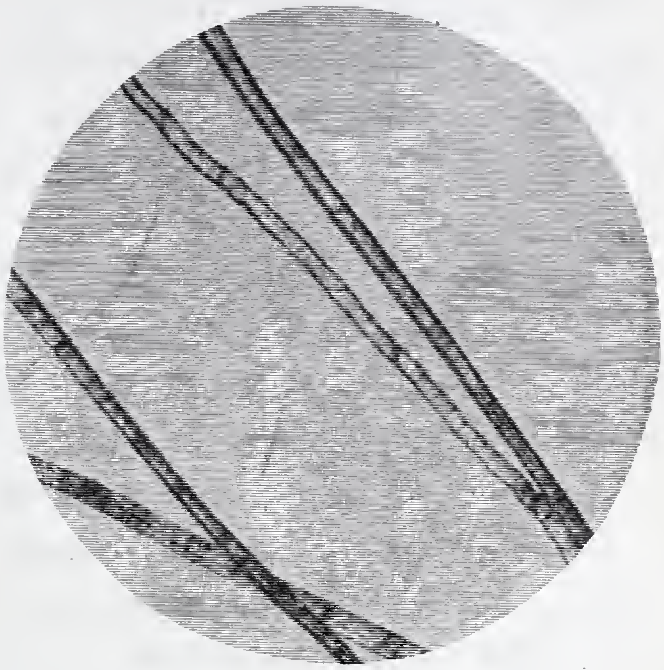
Paper was long made by hand, the soft material being extended on frames with screens. Obviously, the development of inventions that characterized the latter years of the eighteenth century caused hope that paper-making would be also benefited. It appears that it was in the closing decade of that century that a Frenchman, Louis Robert, constructed a machine that would make a small continuous roll of paper. The usual difficulties and oppositions that inventors encounter were Robert's portion, but efforts went on, other workers pushed the matter further and finally the firm of H. and S. Fourdrinier, prominent stationers of London, furnished the necessary capital. After efforts by several ingenious mechanics, the machine was brought to a high degree of perfection and in 1803 produced an endless web of paper. The Fourdrinier machine gave a great impetus to the use of paper.

The problem then set before the paper manufacturer was to secure a cheaper and more abundant source of pulp. The first efforts were principally directed to the use of straw. Paper from this source was made by several persons. The comminution and pulping of the straw was carried out mostly by mechanical means, and produced an unsatisfactory material.

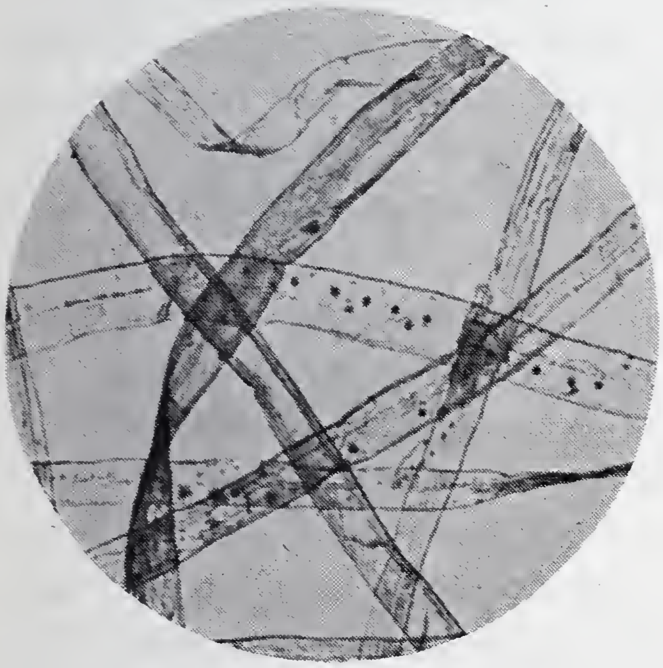
The great increase in the use of paper which is so characteristic of the present age is due to introduction of *chemical* processes for the manufacture of a workable pulp. Cellulose, which as noted above, is the essential ingredient of a good commercial paper, exists in great abundance in the vegetable kingdom, but in most cases intimately associated with resinous or gummy materials that completely



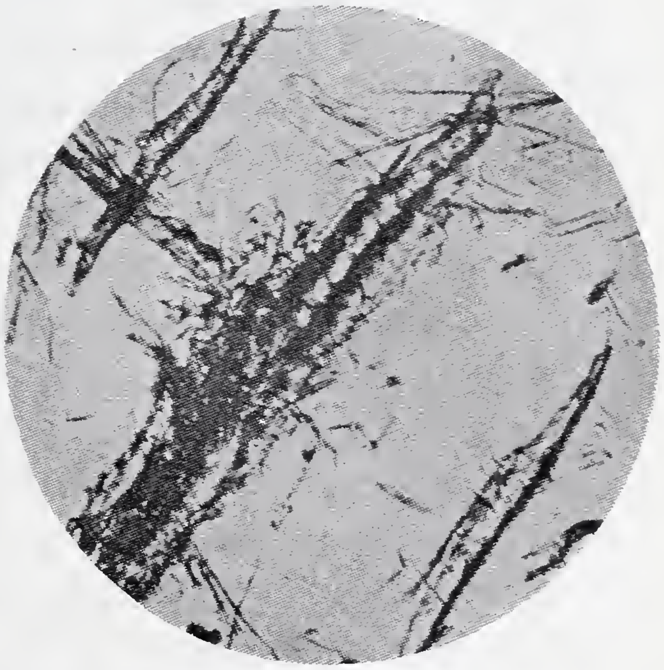
Cotton



Linen



Spruce Pulp



Ground Spruce Wood

Photomicrographs by U. S. BUREAU of Standards
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interfere with its separation by mechanical means. These cementing substances are more or less acidic in nature and, therefore, it was early suggested that lyes might be used for dissolving them. Experiment in open vessels at the usual boiling point did not yield satisfactory result but by closing the boiler so that a temperature of about 300° F. can be obtained corresponding to a pressure of about sixty pounds per square inch, and using a moderately strong solution of caustic soda, the cementing materials are wholly dissolved and the cellulose fiber separated in a soft form which may be easily bleached. Many kinds of wood may be thus used and the manufacture of "wood-pulp" became rapidly a great industry with corresponding expansion of all the lines in which paper is used. The invention of stereotyping and the typesetting machine has served to increase much further the development of printing, especially of the daily newspaper with its enormous Sunday editions.

The urge for more paper gave rise to experiments in other directions. Among the newer processes are those in which sulphites and sulphates are used. These have special advantages and have been extensively developed.

PAPER FROM WOOD

The most recent and very extensive system of making paper is the use of ground wood. The wood is ground fine on a grindstone. This will, of course, not make a sheet of paper, but a limited amount of pulp is added and the mixture makes the familiar "newsprint" of today, a most flimsy and perishable product. The extensive employment of this method has had two disastrous results. It has caused the rapid destruction of our forests and has made our contemporary records, of which the most important are the newspapers, of a material that will last only a few years. It is a serious question what is to become of our newspapers in the course of a few decades. Even now a newspaper a few years old is discolored and so brittle that it is liable to fall to pieces if handled even gently. There seems to be no hope for the restraint in this matter. The publishing houses all over the world are vieing with one another in issuing larger and larger sheets, and our newstands show the excess to which the use of paper has gone. At the present time it is not only the excessive and wholly unwise use of paper itself, but the *matter* of the printing is in large part of an injurious influence on the moral well-being of the community.

Printing has been called "the art preservative of all arts" and it

has deserved that title, but the abuses that have grown up in connection with it may seriously detract from the usefulness of it.

Gibbon, in speaking of the destruction of valuable Greek MSS on the occasion of the taking of Constantinople by the Turks in 1453, said that fortunately the mechanics of a German town had invented an art which enables literature to defy the ravages of time and barbarism.

THE "WATER MARK"

A feature of the manufacture of the grades of paper intended for writing was the "water-mark." This was produced by the impression of a wire design on the pulp, so as to make the paper somewhat thinner at that place. If the sheet is held up to the light the design can be seen. Occasionally these marks were either dated or the dates of certain designs were known and forgeries could be detected by them. The French franc notes bear a water-mark of the conventional Liberty head. Water-marks gave the names to some styles of paper. A post-horn, for instance, caused the grade to be known as "post" paper. It is said that the term "fool's cap" paper came from the printing of a design of a fool's cap and bells as a mark.

In the days when most paper was of good quality there was a large utilization of the waste material, but at the present time when the bulk of the paper is so largely ground wood, there is little use for it and hence the formidable problem of waste paper. Some use has been found for making low grades of cardboard stock, but the relief seems to be slight if we may judge by the condition of city streets.

"What is the end of fame? 'Tis but to fill
A certain portion of uncertain paper."

THE ROMANCE OF THE OCCULT

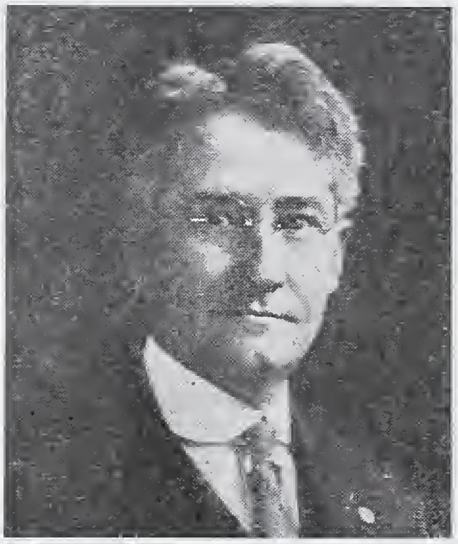
By Charles H. LaWall, D. Sc., Ph. M.,

Professor of Pharmacy, Philadelphia College of Pharmacy and Science

> "Error is always more busy than ignorance.
> Ignorance is a blank sheet on which we may write, but error is a scribbled one from which we must first erase."—*Colton.*

WHAT is occultism? What are the occult sciences?

The word "occult" has had many meanings. Occult science or occult philosophy in the Middle Ages was simply experimental science. This did not necessarily include magic, but as experimental science in either physics or chemistry in this older period was so mysterious in its effects, the ignorance and superstition of the time invested the practitioners with supposed supernatural qualities and associations, and as there is apparently no limit to human credulity, the literature of alchemy, medicine, and pharmacy, from the eighth to the eighteenth century, is a bewildering mixture of fact and fancy. Even the later centuries have not been free from reproach in this respect, for Tyndall says:



Charles H. LaWall, D. Sc., Ph. M.

> "Were the characters which superstition assumes in different ages an indication of man's advance or retrogression, assuredly the nineteenth century would have no reason to plume itself in comparison with the sixth B. C."

The modern use of the word "occult" is either in connection with something "mysterious or transcendental" or "passing beyond the bounds of scientific knowledge," or else it is applied to something that is "not apparent upon mere inspection or deducible from what is so apparent," and its meaning is "opposed to manifest." If we take this latter definition literally, hash might be legitimately considered to be an occult product. The sense in which it is used in this connection is when it is applied to "occult" blood in urine or feces.

For the purpose of this lecture I shall take the first of these meanings and shall attempt to describe some of the interesting phases and varieties of misbeliefs and superstitions which have made so alluring the literature of these older periods, when myths and legends were pandemic and when the phenomena which are commonplace to us were enveloped in a halo of mysticism and magic. Lang says: "The narrower the range of man's knowledge of physical causes, the wider is the field he has to fill up with hypothetical causes of a metaphysical or supernatural character."

The psychological effect of words is often profoundly stimulating to some subconscious, unverbalized feeling which is common to the great majority of the human race. The terms "esoteric," "cabalistic," "arcane," "hermetic," "magic," "mystic," and others of similar character, possess a compelling appeal to many individuals who lose their mental bearings as soon as they are exposed to the sound or the sight of them. So, too, the words "fairy," "dryad," "faun," "satyr," "witch," "wizard," "warlock," "necromancer," "sylph," "salamader," "undine," "nymph," and "gnome," and many others, conjure up memories and impressions, elusive and fascinating in their mysterious indefiniteness.

When Peter Pan advances to the front of the stage in Barrie's famous play of that name, and appeals to all of those in the audience who believe in fairies to applaud, and thus save the life of Tinker Bell who is fading away because of lack of faith in fairies on the part of the audience, many who respond do so perfunctorily, but there are those in every audience who *do* believe in elves and sprites and the power of fern seed to confer invisibility upon the possessor, and for these select few fairies do and always will exist.

I find myself confronted with such a voluminous wealth of material that I shall have to skim over many of the subjects in a synoptical manner and confine myself to outlines and definitions mainly, sketching a picture as I go along and leaving my hearers to fill in the details later if they so desire.

MAGIC

"Error is a Hardy Plant, it Flourishes in Every Soil." Magic is the first subject that comes under the head of the occult sciences. There are many subdivisions of the art, among which are white magic, black magic, ceremonial magic, and red magic.

The word "magic" comes from a root word meaning priest. A "mage" or "magus" was one of the priestly caste of wise men of

the Medes and Persians, and this was the group from which Caspar, Balthasar and Melchior came to the nativity of Christ in Bethlehem. "Magism" is the philosophy of the magi.

A Group of Famous Occultists, from a Work by John Dee

Eliphas Levi, an occultist of the nineteenth century, defines magic as "the traditional science of the secrets of nature which has come down to us from the Magi." By this is meant the Magus

"Who uttered his oracles sublime
Before the Olympiads in the dew
Of early dawn and dusk of time."

Chaldea was the cradle and the sanctuary of the transcendental sciences. The magicians of Egypt played an important part in the

controversy between Pharaoh and Moses over the departure of the children of Israel, but Moses and Aaron seem to have been able to hold up their side of the argument with their magical arts.

The epistemological aspects of magic have led to the publication of many historical and philosophical works during recent years upon

Title Page of a Modern Book Upon Occult Subjects

various phases of occultism, but there has also appeared a voluminous literature which appears to have for its object the encouragement of those who seek to accomplish results by the use of occult methods.

Pneumatology, from the Greek *pneuma,* air, and *logos,* to speak, is the study of the beliefs, practices, and organizations of men with reference to a supposed world of spirits. This includes comparative mythology, spiritology, and daimonology.

White magic is beneficent magic. One of its principal objects is the evocation of angels. This brings us to the consideration of what is an angel.

Angels are the messengers of Christian tradition. The rabbinical commentary on Genesis by Rabbi Jacob says "the angels have no free will and cannot be otherwise than good." They respond to evocations, perform miracles, garner the prayers of the faithful, overwatch human beings and engage in an everlasting spiritual warfare with the powers of darkness. The "Incommunicable Name" is a fountain or arcane power in this evocation and the Hebrew alphabet plays a significant part.

WHITE MAGIC. THE EVOCATION OF ANGELS

There are seven Stewards of Heaven: Arathron, Bethor, Phaleg, Och, Hazith, Ophiel, Phul. There are 196 Olympic regions over which they reign. For example:

THE SEVEN STEWARDS OF HEAVEN

> "Arathron is the celestial spirit of Saturn; he can operate natural things prepared by astrological influences; he may change everything ,into stone, whether animals or plants, but they will preserve their exterior appearance. He changes treasures into coals and coals into treasurers. He gives familiar spirits with definite power; he teaches alchemy, magic, and natural philosophy; he joins men to gnomes and earth spirits; he renders people invisible; he governs fertility and conception; he teaches the discovery of lead, its manipulations and its changes into gold; he teaches the art of curing the smaller animals of their diseases, such as goats, poultry, etc. He gives intelligence of prisoners and of sick people, despatches ministering spirits, who serve after his own manner, enlarges the understanding, gives excellent advice on all elevating subjects, and is most exact in his calculations. He must be evoked on a Saturday, at the first hour of sunset in the increasing moon."
>
> And so on down the entire list.

There are nine steps of preparation or indispensable attributes for successful evocation of angels, among which are the following:

> "The magus must be useful to his neighbors and glorify his Maker. He should be discreet and faithful and should never reveal what he has been told by a spirit. He should avoid all superstition, which consists in the attribution of divine power to things which are without divinity. He must avoid the deceitful imitations of the devil, who, by the perversion of the theurgic

powers concealed in the Word of God, becomes a fraudulent imitator of things which belong to God. He must present himself with a pure heart, an undefiled body, and innocent hands. After bathing and fasting for three days he must seek a retired spot, where, free from observation, he can recite certain prescribed invocations."

THE EVOCATION OF THE SPIRITS OF THE ELEMENTS

The magical doctrines of the evocation of the elements has furnished the material for some of the most popular and attractive fictions in literature, such as Pope's *Rape of the Lock,* *Undine* by Foqué, Burton's *Arabian Nights,* and the works of Spenser, Ariosto, Goethe, Schiller, Keats, Washington Irving and Hawthorne. Algernon Blackwood, Sax Rohmer, and Bram Stoker are modern writers who deal with various phases of occultism. To quote from Pope:

"Some secret truth from learned pride concealed,
To maids alone and children are revealed."

"Know then unnumbered spirits round thee fly,
The light militia of the lower sky."

"The spirits of fiery termagants in flame,
Mount up and take a salamander's name."

"Soft yielding minds to water glide away,
And sip with nymphs their elemental tea."

"The graver prude sinks downward to a gnome,
In search of mischief still on earth to roam."

"The light coquettes in sylphs aloft repair,
And sport and flutter in the fields of air."

"For spirits, freed from mortal laws, with ease
Assume what sexes and what shapes they please."

There are said to be four classes of "elements" (or elementals) with intelligences, normally unseen, some of them friendly to man and some of which are his deadly enemies. They are without souls. Their lives depend upon the continuance of some natural object, hence they are without immortality. An elementary spirit may procure a soul by a loving union with some one of the human race. The reverse effect is sometimes produced and the soul of the mortal is forever lost.

The four elements handed down from the time of Empedocles, earth, air, fire, and water, each has associated with it a sub-human intelligence. The earth is inhabited by gnomes; the air is populated with sylphs; fire is associated with the exalted and glorious nation of salamanders; the waters are filled with the delightful and beautiful undines, or nymphs.

AIR; EARTH; FIRE; WATER

Robert Fludd, an English Rosicrucian and mystic, connected these groups of intelligences with certain angelical choirs. Thus the cherubim are terrestrial, the principalities are aerial, the seraphim are of a fiery character, and the archangels are aquatic.

A work of the Abbé de Villars called "Comte de Gabalis," published at the close of the eighteenth century, gives a popular presentation of the elementary spirits, in which he says:

> "The salamanders are composed of the most subtle parts of the spirit of fire, conglobated and organized by the universal fire, so called because it is the principle of all the motions of nature. In the same manner the sylphs are composed of the purest atoms of air, nymphs of the most ethereal particles of water, and gnomes of the most refined earth. The primeval Adam was in correspondence with these perfect creatures, because, being composed of the finest matters of the four elements, he contained in himself the physical perfection of each of these four races, and was therefore their natural king. But when sin had precipitated him among the excrements of the four elements, this harmony was shattered, he became gross and impure, and no longer bore any relation or proportion with these so pure and subtle substances."

Formulas and methods are given by this author for recovering the empire and control over the four classes of elementals, as they are usually called. Paracelsus devoted much space to the consideration to the spirits of the air or sylphs, and a method for the control and interrogation of elementary intelligences is given by Eliphas Levi. Eliphas Levi was a French mystic and magus of the nineteenth century, who wrote many works on occultism, among which were the *Dictionary of Christian Literature,* the *Doctrine and Manual of Transcendental Magic,* the *Sorcerer of Mendon, The Major and Minor Keys of Solomon,* and other works of the same character. The name "Eliphas Levi," to which is sometimes added that of "Zahed," is the *nom de guerre* of an apostate French priest named Alphonse Louis Constant, who was born about 1810 and died in 1875.

Levi states that:

"The air is exorcised by the sufflation of the four cardinal points, the recitation of the Prayer of the Sylphs and the following formula:—The Spirit of God moved upon the water, and breathed into the nostrils of man the breath of life. Be Michael my leader and be Sabtabiel my servant, in the name and by the virtue of light. Be the power of the word in my breath, and I will govern the spirits of this creature of Air, and by the will of my soul, I will restrain the steeds of the sun, and by the thought of my mind, and by the apple of my right eye. I exorcise thee, O creature of Air, by the Pentagrammaton, and in the name Tetragrammaton, wherein are steadfast will and well directed faith. Amen. Sela. So be it.

"Water is exorcised by the laying on of hands, by breathing, and by speech, mixing consecrated salt with a little of the ash which is left in the incense pan. The aspergillus is made of branches of vervain, periwinkle, sage, mint, ash, and basil, tied by a thread taken from a virgin's distaff, with a handle of hazelwood which has never borne fruit, and on which the characters of the seven spirits must be graved with the magic awl. The salt and ashes of the incense must be separately consecrated. The prayer of the Undines should follow.

"Fire is exorcised by casting salt, incense, white resin, camphor, and sulphur therein, and by thrice pronouncing the three names of the Genii of fire—MICHAEL, king of the sun and of the lightning; SAMAEL, king of volcanoes; and ANAEL, king of the Astral Light; then by reciting the prayer of the Salamanders.

"The earth is exorcised by the sprinkling of water, by breathing, and by fire, with the perfumes proper to each day, and the prayer of the Gnomes.

"It must be borne in mind that the special kingdom of the Gnomes is at the north, that of the Salamanders at the south, that of the Sylphs at the east, and that of the Undines at the west. They influence the four temperaments of man, that is to say, the Gnomes influence the melancholic, Salamanders the sanguine, Undines the phlegmatic, and Sylphs the bilious. Their signs are—the hieroglyphs of the Bull for the Gnomes, who are commanded by the magic sword; of the Lion for the Salamanders, who are commanded with the forked rod, or magic trident; of the Eagle for the Sylphs, who are ruled by the holy pentacles; and, finally, of Aquarius for the Undines, who are evoked by the cup of libations. Their respective sovereigns are Gob for the Gnomes, Djin for the Salamanders, Paralda for the Sylphs, and Necksa for the Undines.

"Like so much of occult nomenclature, these names are of a generic and arbitrary kind, and appear to be devoid of real im-

portance; in the present instance, they are borrowed from folk-lore.

"It must be remembered that the words 'Elemental' and 'Elementary' are not exactly controvertible terms; as the latter is frequently used by 'theosophists' to denote the astral remains, or 'shell,' of a deceased person who has led a gross and evil life on earth, and whose vanishing personality remains for some time in the earth atmosphere, seeking to annoy the living.

"When an elementary spirit torments, or, at any rate, troubles, the inhabitants of this world, continues Eliphas Lévi, it must be adjured by air, water, fire, and earth, by breathing, sprinkling, the burning of perfumes, and by tracing on the ground the Star of Solomon and the sacred Pentagram. These figures should be absolutely correct, and drawn either with the ash of consecrated fire, or with a reed soaked in various colours, mixed with pulverised loadstone. Then, holding the pentacle of Solomon in the hand, and taking up by turns the sword, rod, and cup, the Conjuration of the Four should be repeated.

"This Conjuration should be preceded and terminated with the sign of the cross, made after the Kabbalistic manner. Raising the hand to the forehead, the Magus should say: 'Thine is,' then, bringing it to the breast, 'the kingdom'; transferring it to the left shoulder, 'justice'; finally to the right shoulder, 'and mercy'; then, joining both hands, 'through the generating ages.'

"To conquer and subjugate the elementary spirits, we must never be guilty of the faults which are their characteristics. Never will a capricious and changeable mind be able to rule the Sylphs. Never will a soft, cold, and fickle disposition be qualified to govern the Undines; anger irritates the Salamanders, and gross covetousness makes those whom it enslaves the sport and plaything of the Gnomes. But we must be prompt and active, like the Sylphs; pliant and observant as the Undines; energetic and strong like the Salamanders; laborious and patient, like the Gnomes: in a word, we must overcome them in their strength without ever being overcome by their weakness."

—From *The Occult Sciences,* by A. E. Waite.

Medieval magic is filled with the histories of familiar spirits attached to the persons of magicians. They perform all commands without any apparent reward and without exacting any of the spiritual sacrifices usually supposed to be required from dealers with the supernatural, as exemplified in Faust.

The metals which correspond to the elementals are gold and silver for air, mercury for water, iron and copper for fire, and lead for earth. Divination by the aid of these elementals is called aeromancy, hydromancy, pyromancy, and geomancy, respectively, for air, water, fire, and earth.

In this same connection must be mentioned a number of terms encountered in literature, both poetry and prose. An oread is a mountain nymph, a dryad is a nymph of the woods, and each tree was supposed to be the home of a member of this group. Hawthorne says, in one of his fanciful tales: "Knock at the rough rind of this ilex tree and summon forth the dryad," while Longfellow, in commenting upon the nomenclature of the principal streets of Philadelphia, says: "There the streets still re-echo the names of the trees of the forest, as if they fain would appease the dryads whose haunts they molested." A hamadryad was a wood nymph who lived and died with the tree she inhabited. A nymph was one of a numerous group of inferior divinities who took the form of beautiful maidens, eternally youthful. A naiad was a nymph of the springs, while a nereid was a nymph of the seas. A nixie was a swan maiden.

A troll in Icelandic literature was a giant, but in Scandinavian folk lore is a diminutive being which can render itself invisible and which keeps up a friendly intercourse with human beings. Trolls are sometimes obliging and at other times malicious or mischievous. They resemble the brownies of Scotland.

The Malay word "jin" corresponds to the Arabic "djin," "jinn," or "jin," which stood for fairies who, according to the Arabian fable were created from smokeless fire 2000 years before Adam was made of earth. They are generally supposed to be evil spirits and are governed by King Solomon.

One of the factors of white magic, according to some authorities, is a complicated symbolic design representing Parabrahma or "the unmanifested absolute," if you happen to know what means.

BLACK MAGIC. THE EVOCATION OF DEMONS

Black magic, or Goetic magic, as it is sometimes called, from the Greek root word for sorcery, is concerned with the evocation and liberation of malign forces. White magic was permissible: black magic was forbidden. The result was that much that passed current as white magic was merely a disguised goeticism, and the impatient magus who failed to follow minutely the ritual details might be surprised to find the resplendent angels bearing horns and cloven hoofs and find himself forever in the power of diabolical and malign forces.

Demons are said to be fallen angels. Some authorities fix the fall before the creation of the present physical world, others with unqualified assurance place the time as the second day of creation.

Milton gives graphic details of the combat between the forces of the upper and nether worlds.

There is a wide gap between the daimon of Socratic philosophy and the arch fiend of the Black Sabbath. The word "demon" originally meant a tutelary deity or a god of lower rank. Later it came to mean a ghost or a departed soul. Not until Christianity of the early centuries attempted to find a place for the divinities of the pagans did the word demon come to have a sinister meaning. The demon of Socrates was a good genius; the demon of Poe's *Raven* was malevolent.

There were no evil demons in pre-Christian times. Milton apparently confuses the demons with the elementals described under white magic, for he says in *Il Penseroso:*

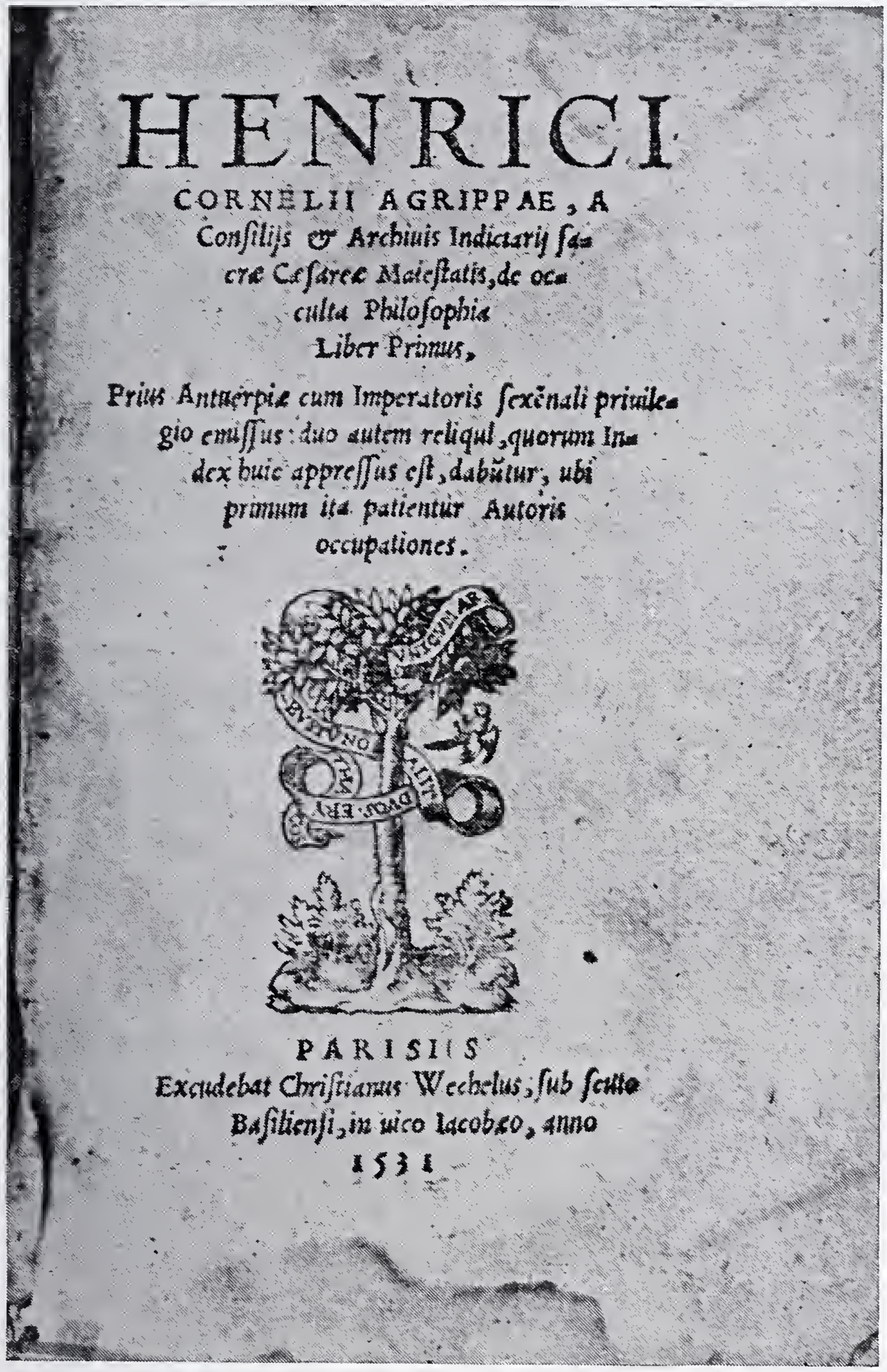
> "Those demons that are found
> In fire, air, flood or underground,
> Whose power has a true consent
> With planet, or with element.

Much of the medieval credulity regarding magic, both white and black, doubtless arose from the fact that some of the authorities who were revered as possessing arcane powers were either connected with the church or protected by its favor, and their works abound with Biblical references and examples.

One of the outstanding characters in the history and romance of the occult sciences was Henry Cornelius Agrippa von Nettesheim. He voluntarily decapitated and curtailed his name and he is known as Cornelius Agrippa. The *Encyclopedia Britannica* refers to him as "a German writer, soldier, physician, and by common reputation, a magician." His life story is a romance in itself. Although a professed mystic who was interested in theosophy and who lectured on the secret doctrines of Hermes Trismegistus at the University of Pavia, he also taught theology for many years and remained a professed Catholic to the time of his death. His most famous work was *De Occulta Philosophia,* the publication of which the Inquisition attempted to suppress without success.

This work was translated into a number of languages in the sixteenth century and modern editions of it have been published. Agrippa, in the preface to his book, warns the reader against taking the name of magic in a bad sense. He admits that he is a magician, but denies that he is a sorcerer. In his letter to John Trithemus, an

abbott of Herbipolis, to whom he entrusted the manuscript and by whose authority it is said to have been published, he warns against false philosophers who by superstitious and dangerous rites bring discredit upon magic. In Trithemus' letter of reply to Agrippa he warns him to "communicate high and secret things to high and secret



HENRICI
CORNELII AGRIPPAE, A
Consilijs & Archiuis Indiciarij sa-
crae Caesareae Maiestatis, de oc-
culta Philosophia
Liber Primus,
Prius Antuerpiae cum Imperatoris sexennali priuile-
gio emissus: duo autem reliqui, quorum In-
dex huic appressus est, dabuntur, ubi
primum ita patientur Autoris
occupationes.

PARISIIS
Excudebat Christianus Wechelus, sub scuto
Basiliensi, in uico Iacobaeo, anno
1531

Title Page of a Noted 16th Century Work on the Occult Sciences

friends only." In 1531 Agrippa's book was published with a dedication to Herman of Wied, Archbishop of Cologne.

One of Agrippa's disciples, Wierus by name, amplified his master's work and has given us a tabulated statement of the whole Satanic monarchy, which is associated with black magic. These are

divided into six groups. The first of these includes princes and grand dignataries of whom Beelzebub is "Supreme chief of the Infernal Court and Empire, and Founder of the Order of the Fly." Satan occupies a subordinate position, being entitled "Leader of the Opposition." Moloch is "Lord of the Land of Tears." Pluto is "Lord of Fire," and Proserpine is "Arch-she-fiend and sovereign Princess of Perverse Spirits."

Among the ministers Baal, who is "Commander in Chief of the Infernal Armies," and also Leviathan, "Lord High Admiral, Knight of the Fly." Lucifer is "Lord Chief Justice," and Alastor is "Commissioner of Public Works." There is also a list of Members of the Household and Masters of the Revels, and even ambassadors to various European countries, Mammon being ambassador to England, and Belial ambassador to Turkey.

The "Order of the Fly" referred to in the titles of the members of the nether empire goes gack to the times of the Egyptians and the Greeks. In the temple at Actium the Greeks used to sacrifice an ox annually to the God of Flies, and Beelzebub was a Syrian god known at that time as the Prince of Flies.

Several famous books were published in the eighteenth and nineteenth centuries on black magic. One of these was the *Grimoire,* or *Book of Conjuring and Sorcery,* by Pope Honorius, published in Rome in 1760. The *Grimoire Verum* and *Grand Grimoire* were similar books which appeared in the next century. The strange and interesting part of black magic is the fact that diabolical practices are invariably prefaced by long and solemn prayers, which emphasize the purity of the magician's intention. A modern writer states that "black magic in its esoteric aspect is a barbarous perversion of legitimate mystic science."

The materials required for the evocation of demons are a certain red stone called ematille, a virgin kid which must be crowned with vervain and decapitated on the third day of the moon, a forked branch of witch hazel which has never borne fruit and which must be cut at sunrise on the day of the evocation. A piece of lodestone is also necessary. A preliminary invocation in connection with this paraphernalia is as follows:

> "By the Grand Adonay, Eloim, Ariel and Jéhovam, I bid thee be united to, and I bid thee attract all substances which I shall require through the night of sublime Adonay, Eloim, Ariel and Jéhovam. I command thee by the antagonism of fire and

water to separate all substances as they were separated on the day of the world's creation. Amen.

"The place of evocation must be a forlorn and isolated spot, and the time night. Thither he must transport the rod, the skin of the kid, the stone called ematille, two vervain crowns, together with two candlesticks and as many candles of virgin wax, made by a virgin girl, and duly blessed. He must take also a new steel and two new flints, with sufficient tinder to kindle a fire, likewise the half of a bottle of brandy, some consecrated incense and camphor, and four nails from the coffin of a dead child. The great Kabbalistic circle must be formed with strips of the kid's skin, made fast to the ground by means of the four nails. Then, with the stone called ematille, a triangle must be placed within the circle, beginning at the eastern point. In the centre of this figure the operator must take up his place; he must deposit the two candlesticks and the two vervain crowns on the right and left of the triangle. The candles should then be lighted, and a brazier, which must be in front of the operator, must be heaped up with charcoal of willow wood, and kindled with the help of a small quantity of the brandy and a part of the camphor, the rest being reserved for the periodical renewal of the fire in proportion to the length of the business.

"Many conjurations are given in the rituals, and these are to be used in succession till the apparition of spirit is obtained. The most powerful, as it is also apparently the most senseless, may be cited as a specimen of the whole.

"Grand Conjuration.

"(Extracted from the veritable Clavicle.)

"'I adjure thee, O Spirit! by the power of the great Adonay, to appear instanter, and by Eloim, by Ariel, by Jehovam, by Alga, Tagla, Mathon, Oarios, Almouzin, Arios, Membrot, Varios, Pythona, Magots, Salphæ, Gabots, Salamandræ, Tabots, Gnomus, Terræ, Cœlis, Godens, Aqua, Gingua, Janna, Etitnamus, Zariatnatmit, etc., A.. E.. A.. J.. A.. T.. M.. O.. A.. A.. A.. M.. V.. P.. M.. S.. C.. T.. G.. T.. C.. G.. A.. G.. J.. F.. Z.. etc.'

"The manifestation of the spirit is guaranteed after a second repetition of these sublime words, when the operator may demand what he requires, and enforce it by the terrors of the Blasting Rod, which tortures all Infernals when it is plunged into the consecrated flame. The demon is generally ordered to discover the nearest buried treasure, which is done on the condition that the secret is kept inviolate, that the Magus is charitable to the poor, and that he receives a gold or silver coin on the first day of every month.

> "If the operator was deterred by the extreme difficulty of complying with the ceremonial requirements of Black Magic, but not dismayed by the character of its proceedings, his masters in infernal knowledge could provide him with a simpler ritual at an increased personal expense. He was free to compound with perdition for a slightly less elaborate performance, if he would enter into a compact with the fiend whom he chose to evoke, and dispose of his soul in eternity for certain defined favours, invariably of a paltry character, which hell would guarantee him in time. The particulars of this process were contained in the 'Sanctum Regnum,' or the 'True Method of making Pacts with all Spirits whatsoever.' "—(From *The Occult Sciences* by Waite.)

Natural Magic is the kind that is performed by so-called conjurors and magicians who simply take advantage of natural laws in a secret and mysterious way for the purpose of deceiving the observer. Natural magic also includes the kind of experiments in physics or in chemistry which may be employed to mystify the uninitiated.

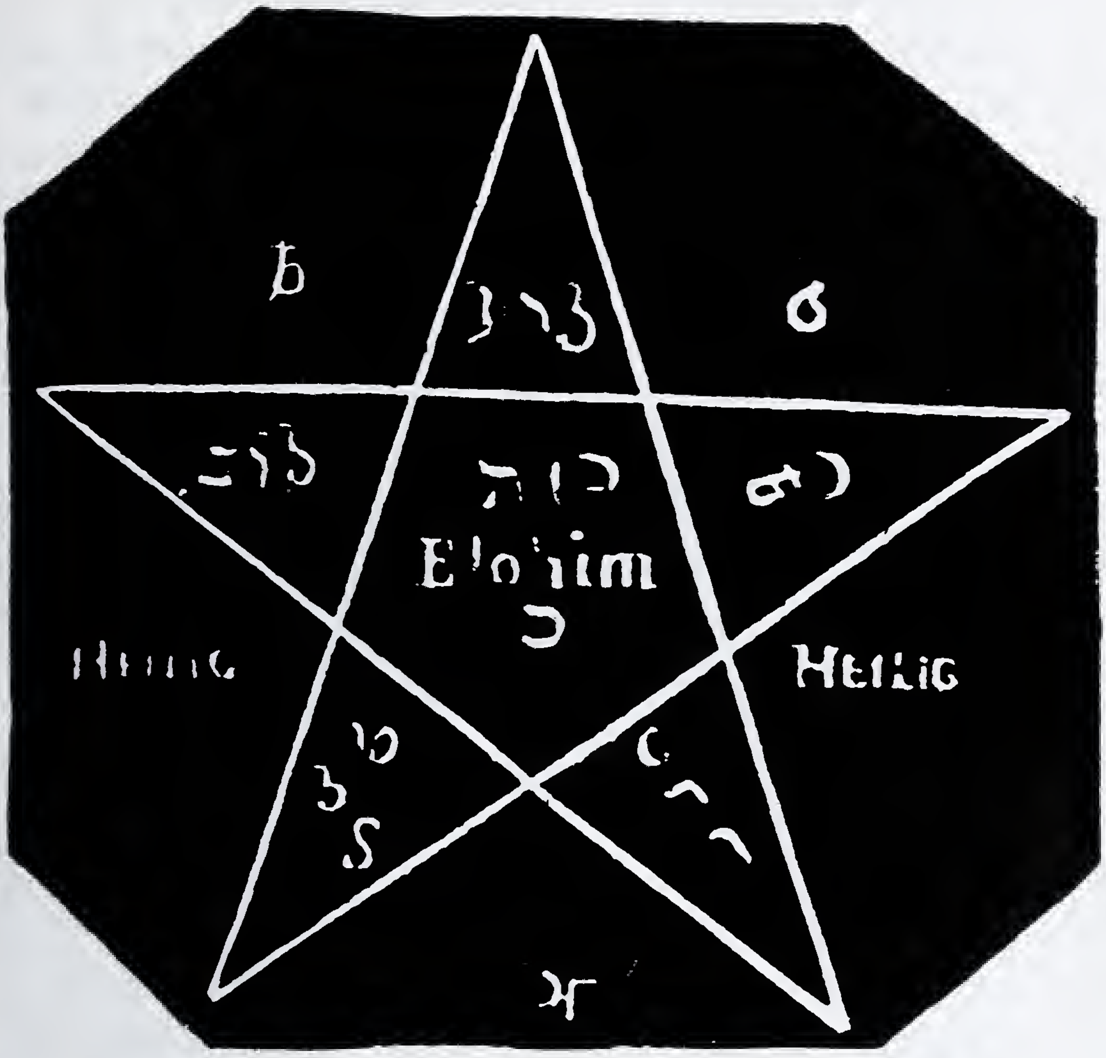
Red Magic is the highest kind of esoteric magic, known only to the initiated and concerning which nothing is written or told.

Ceremonial Magic. This includes white magic and black magic, which have already been discussed. It also comprehends necromancy, which is the evocation of the spirits of the dead; the mysteries of the pentagram and similar figures reputed to possess magical properties; the consecration of talismans; witchcraft, and transformations.

Necromancy. This is a form of magic in which ceremonies and rituals are used to evoke the shades of the departed. This branch of magic is divided into two kinds—the necromancy of light, in which prayers, pentacles, and perfumes are used, and the necromancy of darkness, in which blood, imprecations, and sacrileges are employed. Swedenborg was a famous necromancer or at least communicated habitually with deceased persons. These evocations are accompanied by elaborate ritual and ceremonies. In some cases the preparatory period is of twenty-one days' duration.

Black necromancy goes back in its history to the time of the Sorcerers of Thessaly. A pit was first dug, and on its brink a black sheep was killed; then certain evil spirits who come to drink the blood are driven away by the magic sword. Hecate and other infernal gods were then called upon and triple invocations of the desired shade followed.

In the Middle Ages the black necromancers practiced ghoulish rites and after profaning tombs compounded their unguents and philtres with the grease and blood of corpses. These ingredients were compounded with aconite, belladonna, and poisonous fungi.



Example of the Pentagram with Cabalistic Characters and Words

These repulsive combinations were heated over fires fed by human bones and stolen crucifixes. As a final touch they added the ashes of stolen consecrated hosts and the dust of dried toads.

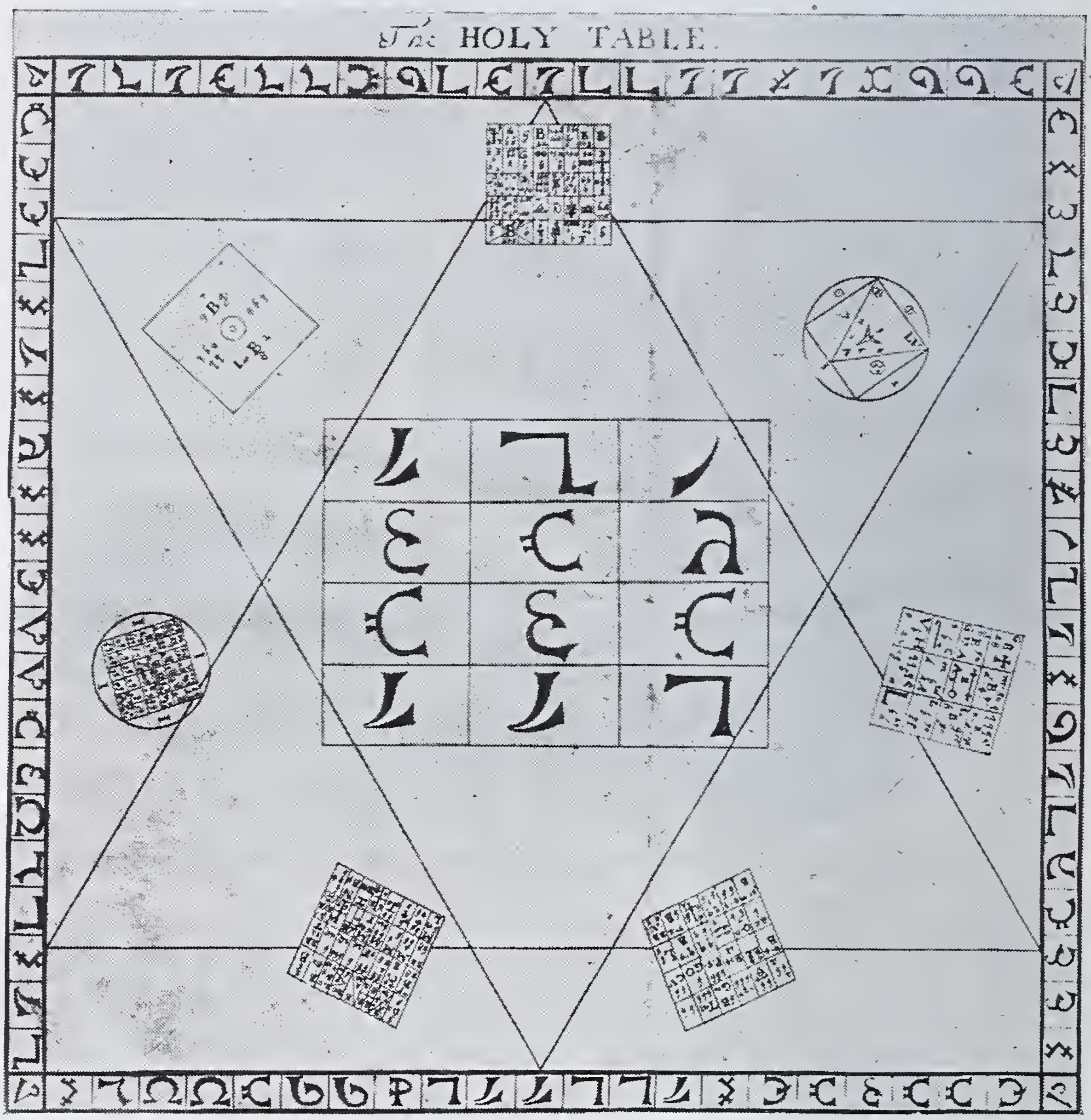
The *Pentagram* or pentacle is the five pointed star. This mathematical figure has had an association with the occult from the earliest times. It was used as a symbol by the Pythagoreans, who began their letters with it.

The Seal of Solomon, which consists of two interlaced isosceles triangles is also credited with esoteric powers, particularly in warding off malign influences. The Seal of Solomon is sometimes erroneously called a pentagram. The word "pentacle" is sometimes loosely applied to any talisman bearing a geometrical design.

The Pentagram is the star of the Magi. According to its position, it represents good or evil, order or disorder, initiation or profana-

tion, Lucifer or Vesper, Mary or Lilith, light or darkness, victory or death. With one angle ascendant and two pointing downward it is the sign of the Saviour and symbolizes all that is good and perfect. With two angles in the ascendant and one pointing downward it represents Satan, or the Goat of the Sabbath.

Both the Pentagram and the Seal of Solomon are employed in a traditional, if not an actively superstitious manner, in the Penn-



Mystical Table from Work by John Dee

sylvania German section of the eastern part of the United States, outlined on the gable ends or sides of barns and outbuildings as a protection against disease or injury to the cattle or crops contained therein.

The Pentagram, to be efficient for evocational purposes, should be accompanied by certain arcane words and symbols. Among these the most potent is the Tetragrammaton, or mystic word of four letters. An example of such a word is the name "JeHoVaH," as

written with four Hebrew letters. The mirific or wonder-working word is known only to the initiated. It is said that he who knows the true pronunciation of the word has unlimited power over unseen things. This name was said to have been one of the secrets of the Holy of Holies of ancient Israel. Its use is perilous to the uninstructed. The sacred word *Om,* derived from the Sanskrit, is invested with peculiar sanctity in the Hindu and Buddhist religions. An example of its use in Malaysia, chanted by the *bomor* or medicine man, for use in cases of snake bite or stings of centipedes and scorpions, is as follows:

> "Peace be with you!
> OM! Potent this charm!
> Fain would I charm this into the flesh,
> The reins, the sinews,
> Charm this into the bones!
> Charm given of Allah, given too of Muhammed,
> The Apostle of God."

Talismans have always played an important part in magic. Some of these have been published in various works upon the subject. One work which is rich in ceremonial rituals and symbols which has never been reproduced in modern times is the *Enchiridion* of Pope Leo III.

Many works have been reproduced purporting to be derived from the time of King Solomon. These are known as *Claviculæ.*

Paracelsus of medical, pharmaceutical, and chemical fame, is an imposing magical authority. He is said to have used, but did not publish, the ceremonial ritual for many occult practices, and he was a user of and believer in talismans. One of the most widely known of talismanic figures is the celebrated "abracadabra," which is known in several modifications, as follows:

A B R A C A D A B R A	abracadabra	ABRACADABRA
A B R A C A D A B R	abracadabr	BRACADABR
A B R A C A D A B	abracadab	RACADAB
A B R A C A D A	abracada	ACADA
A B R A C A D	abracad	CAD
A B R A C A	abraca	A
A B R A C	abrac	
A B R A	abra	
A B R	abr	
A B	ab	
A	a	

Kopp, in his *Geschichte der Chemie,* states that the power of this talisman is said to be due to the fact that the word is a repetition of the initial letters, in Roman equivalents, of Father, Son, and Holy Ghost, in Greek and Hebrew languages.

WITCHES AND WIZARDS

Witchcraft constitutes a phase of magic which deserves a lecture all to itself. Several kinds of bewitchment were recognized, *i. e.,* voluntary and involuntary, physical and psychical. The word "witch" may be used in either the masculine or feminine sense. It ordinarily signifies one of the female gender, the terms "wizard" and "warlock" being used in the male sense. The word "sorcerer" usually is used synonymously with witch.

Jan Ferguson, in a recently issued book, *The Philosophy of Witchcraft,* says that woman was the first historian, poet, dramatist, theologian, and witch. One of the earliest specific instances of a person referred to as a witch is where Saul, King of Israel, consults the one whom Biblical critics say should be called rather the "Woman of Endor." Some commentators believe her to have been a genuine sorceress, others have argued that she was a skilful intriguer who took advantage of the credulity of Saul. Some of the accounts of this episode use the Greek word "python" to describe this woman. In the New Testament this word means a sorcerer, particularly a ventriloquist. "A certain maid having a spirit of divination met us." Acts xvi, 16. In the original Greek the word translated as spirit of divination is "python." The word also means a soothsaying spirit or a demon in the classical antiquities. The oracle of Apollo at Delphi was a python.

Early Christianity gave the witch a permanent place in society, which led in later centuries to a tragical period of persecution. Ferguson says:

> "Where the Church denounced the witch with hatred the struggling schools of medicine treated her with a contempt that was sometimes hardly justified by the instability of their own researches. Against the ancient philosophy of witchcraft the Church struggled to maintain the spiritual values, and in her frantic zeal to put Heaven within the hail of man commenced the long subservience of eternal verities. Where other sciences advanced theology alone was static. Between the two forces of things proved and things revealed stood the witch with her eternal philosophy of delusion and hope. . . . As sickness

was attributed to the presence of evil spirits, the witch expelled them by pagan incantations; the priest with equal enthusiasm routed them with Christian exorcism."

He also says:

"This deliberate determination of Christianity to adopt the ancient formulas of witchcraft is obvious enough in extracts from the prescriptions of physicians,"

and gives the following example from the *Leech Book of Bald,* a tenth century Saxon herbal:

"Against chills at all hours of the day write on a paper and bind with a cord on the neck of the patient in the evening, the following: 'In the name of our Lord, crucified under Pontius Pilate, by the sign of the cross of Christ. Fevers or quotidian chills or tertian or quartan, depart from the servant of God. Seven hundred and fourteen thousands of angels will follow you, Eugenius, Stephanus, Protacius, Sambucius, Dionisius, Chesilius, and Quiriacus.' Write these names and let the patient carry them upon him."

In a work by Montague Summers, just published, entitled *The History of Witchcraft and Demonology,* the author includes under the heading of *Witchcraft:* Sorcery, Black Magic, Necromancy, Occult Divination, Satanism, and every kind of malign occult art. He shows the witch as an "evil liver; a social pest and parasite; the devotee of a loathly and obscene creed; an adept at poisoning, blackmail and other creeping crimes; a member of a powerful secret organization inimical to Church and State; a blasphemer in word and deed; swaying the villagers by terror and superstition; a charlatan and a quack sometimes; a bawd; an abortionist; the dark counsellor of lewd court ladies and adulterous gallants; a minister to vice and inconceivable corruption; battening upon the filth and foulest passions of the age."

Witchcraft has played an important part in the world's history. At the time of the psychological epidemic in Europe, particularly during the sixteenth and seventeenth centuries, when witches were believed to be everywhere, not less than 100,000 were put to death, most of whom made "voluntary" confessions when subjected to torture. One single jurist, Benjamin Carpzov by name, is said to have sentenced 20,000 witches to death himself. The last execution of a

witch took place in Scotland in 1722, in Spain in 1781, in Germany in 1793, and in Peru in 1888.

The Sabbat or Sabbath, also known as the Brocken Assembly, was a periodic gathering of witches who were believed to be transported thither upon the besom or broom. The word Sabbat is not derived from the same root word as the Sabbath, meaning the seventh day or day of rest. A coven was a group of witches. Walpurgisnacht was suposed to be the time of the annual festival of European witches in the Harz Mountains.

The belief in the evil eye is a modification of witchcraft and is also the "poltergeist" or jocular spirit who plays mischievous tricks instead of working injury. In Germany and in the German-settled districts of the United States a witch is called a "hexe."

A ghastly commentary on the uses to which witches' bodies were sometimes put is found in a recent catalogue of old manuscripts offered for sale by a European dealer. One of these is claimed to have been written on the specially prepared skin of a young woman executed for sorcery and whose body had been stolen from the gallows.

There are a number of miscellaneous terms used in connection with witchcraft in particular. The "larva" in Roman mythology was a ghost, a spectre or a shade. The "lamia" was an enchantress who enticed children for the purpose of feeding on their flesh or blood, and was practically the same as the vampire of later days, which was a mythical blood-sucking ghoul. The "lemures" were evil-disposed shades who did mischief to the living, particularly at night. They were exorcised annually, in medieval times, by the head of the household at midnight on May 9th, 11th or 13th. Milton says "The Lars and Lemures moan with midnight plaint."

The werewolf or lycanthrope was a human being who could assume the shape of a wolf for his or her nefarious purposes. The French call the werewolf a *loup garou*. The "concubitus," "incubus," or "succubus" are all terms that are fully defined and discussed in many works of reference. They are associated with dreams or nightmares.

The psychopomp was the guide or conductor of souls to the underworld, and Hermes was given this title by the Greeks. Metempsychosis is concerned with the changing of the souls or personalities of two human beings.

THE QUEST OF THE ALCHEMIST

Alchemy. The cult and practice of alchemy, which was a curious blend of abstract philosophy and laboratory experiments, has always been concerned with occult beliefs and practices, to a certain degree. The history and romance of alchemy have been repeatedly discussed and are available in the literature of pharmacy and chemistry. The Greek poet Theophrastos, whose work has been interestingly described by the eminent historian of chemistry, Dr. C. A. Browne, writes thus mystically concerning the philosopher's stone:

> "Though not a stone, it yet is made a stone
> From metal, having three hypostases,
> For which the stone is prized and widely known;
> Yet all the ignorant search everywhere
> As though the prize were not close by at hand.
> Deprived of honor yet the stone is found
> To have within a sacred mystery,
> A treasure hidden and yet free to all."

Theophrastos also eulogizes the altruistic aim of alchemy in the following lines:

> "But most of all we wish with one accord
> All mortals to be taught and disciplined
> And trained in wisdom of the sophist school,
> That they might shape themselves to perfect men,
> That they might know the bounds of Nature's realm,
> (How all things thrive and mix and interweave)
> And last that they may nothing speak except
> What words the wise old masters used to say.
> These masters urge all mortals who are wise
> To be instructed in the mystic lore
> Of sacred rites, whose meaning they proclaim
> By actions rather than by word of mouth."

One of the most interesting of philosophic articles upon the subject of alchemy is by Professor Arthur John Hopkins, who essays to prove:

1. That the fundamental art—the art that led up to alchemy—was the dyeing of fabrics, especially with Tyrian purple.
2. That by this fundamental art was absorbed the art of what we call bronzing, but what the Egyptian artisans called the tincturing or baptizing of metals.
3. That there was a close connection between these two decorative color processes.

4. That metals were identified by their original colors, but more surely by their bronzes.
5. That this last conception was upheld by Greek philosophy which was invoked in support of the newer engrafted alchemistic philosophy.
6. That the transmutation claimed and attained by the Egyptians was essentially a color transmutation, an artistic interpretation of laboratory experiments. To this transmutation was allied the transmigration of souls of the Egyptian religion.
7. That the conception of the philosopher's stone is in accord with this interpretation.

This entirely new theory of alchemy would divorce it entirely from occultism, but the actual practice as conducted by students and adepts in later centuries was much involved in mysticism.

Mysticism. Mysticism is not necessarily a part of occultism, but many noted mystics have been credited with occult powers. The word "mystic" comes from a Greek root word meaning to be blindfolded and initiated. Its definition refers to anything obscure, mysterious, or incomprehensible.

There have been many sects of avowed mystics, among the most important of which are the Quietists, the Pietists, and the Gichtelians, which are described in general reference books.

The list of individuals who have been credited as being mystics are included in a separate library of works in which each volume is concerned with the life of a single individual. The names are as follows: Joan of Arc, J. B. Van Helmont, Raymond Lully, Zoroaster, Martin Luther, John Dee, Franz A. Mesmer, Saint Martin, Cornelius Agrippa, Joseph Glanvil, St. Francis of Assissi, Jacob Boehme, and Roger Bacon. This list might be extended indefinitely, but few would deny a place to Swedenborg, and the Cambridge Platonists are also entitled to consideration.

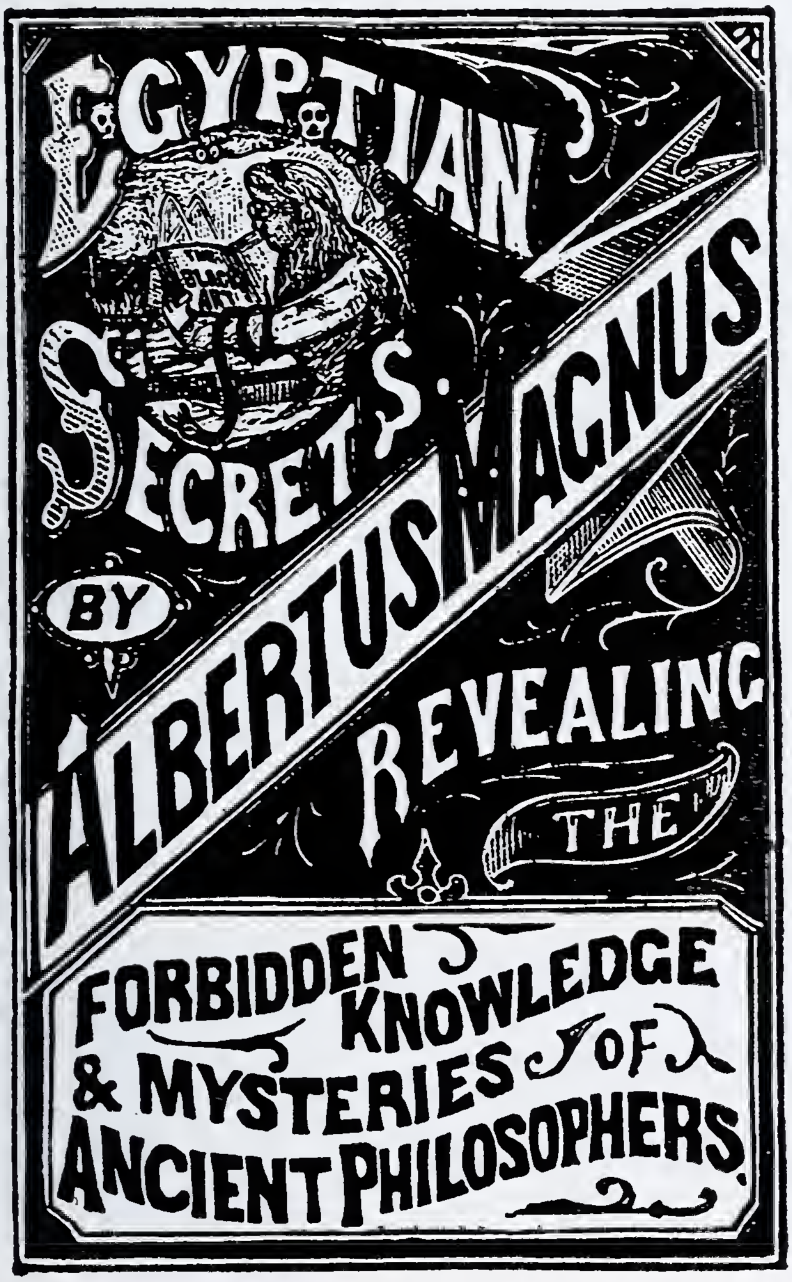
CABALISM

Cabalism or *Khabbalism* is a mysterious traditional Hebrew doctrine. It is the theosophy or philosophy of the Hebrew religion which became prominent in the tenth century. The term is used also in a generic sense to describe occultism in general or any secret science.

Several manuscripts have played a part of the development of the Cabala. One of these is attributed to Enoch, seventh lord of the earth after Adam, the Enoch who "walked with God and was not."

One treatise which is concerned with fifteen stars, fifteen herbs and fifteen stones, upon each of which was engraved a figure. This manuscript is attributed by some authorities to Enoch, and by others to Hermes Trismegistus.

The Book of Enoch most prominently associated with the Cabala is a patchwork from several originally independent books which have come to us in fragments of Greek, Ethiopic, and Slavonic

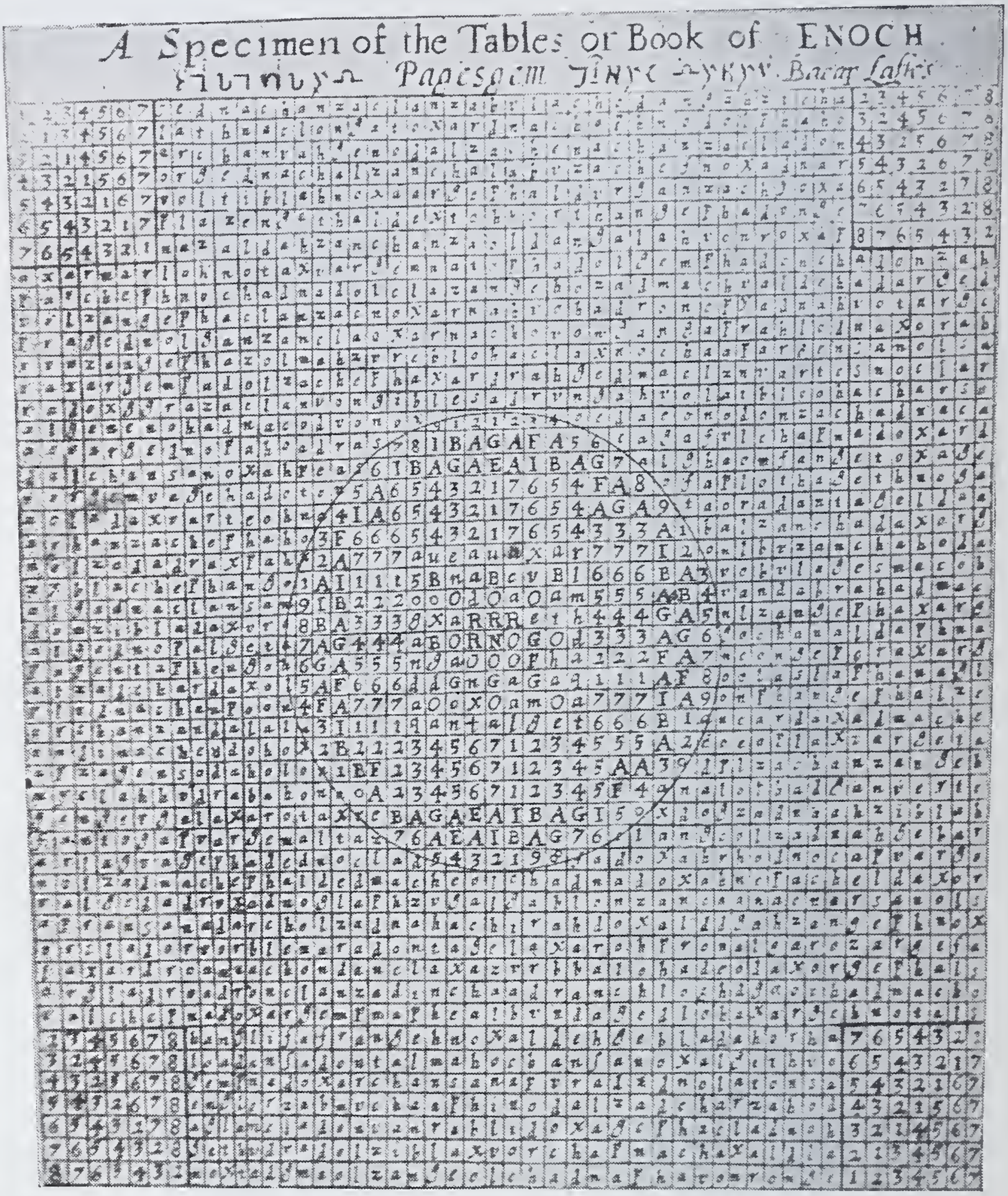


Title Page of a Modern Book Upon Occult Subjects

manuscripts. In this book are mentioned the fallen angels who took unto themselves wives from the daughters of men, following which they instructed the human race in the art of magic and the science of botany. Pharmacy, astrology, geomancy, and aeromancy are also mentioned in this book.

A book attributed to Cadmus, the reputed originator of the alphabet, who founded the sacred city of Thebes, also figures in the

original Cabala. In the Cabala the occult principle is called "the Ancient." It is a mystery of signs and correspondences in which there are thirty-two paths and fifty gates. The thirty-two paths are based upon the ten arithmetical numbers and the twenty-two letters of the Hebrew alphabet. The fifty gates embrace all possible branches



Example of a Page from the Book of Enoch, a Noted Work on Occultism

of human knowledge. According to the initiates of the Cabala, "the word" or human speech constitutes the revelation and the signs are sought in the letters which constitute the primitive alphabet.

The letter which is supposed to be the mother letter and to have generated all other letters is the Jod. The divine tetragram the Jod, He, Vau, and He (reading from right to left) is an important factor in the interpretation of the Cabala. This tetragram is

occasionally used as a symbolic decoration at the top of the title page of medieval scientific works. The first edition of the *Pharmacopœia Londinensis,* 1618, is distinguished by the use of this word in a representation of a cloud at the top of the title page.

The Cabalists have also evolved the sephiric scale of the decade in which divine names and numbers are arranged in a triangle which when rendered into Roman letters is as follows:

J
J A
S D I
J E H V
E L O I M
S A B A O T
A R A R I T A
E L V E D A A T
E L I M G I B O R
E L I M S A B A O T

The Apocalypse or Revelation of St. John is said to contain, in concealed form, the cabalistic secrets of Christianity.

The absolute Cabala is the knowledge of the divine names formed from the tetragrammaton.

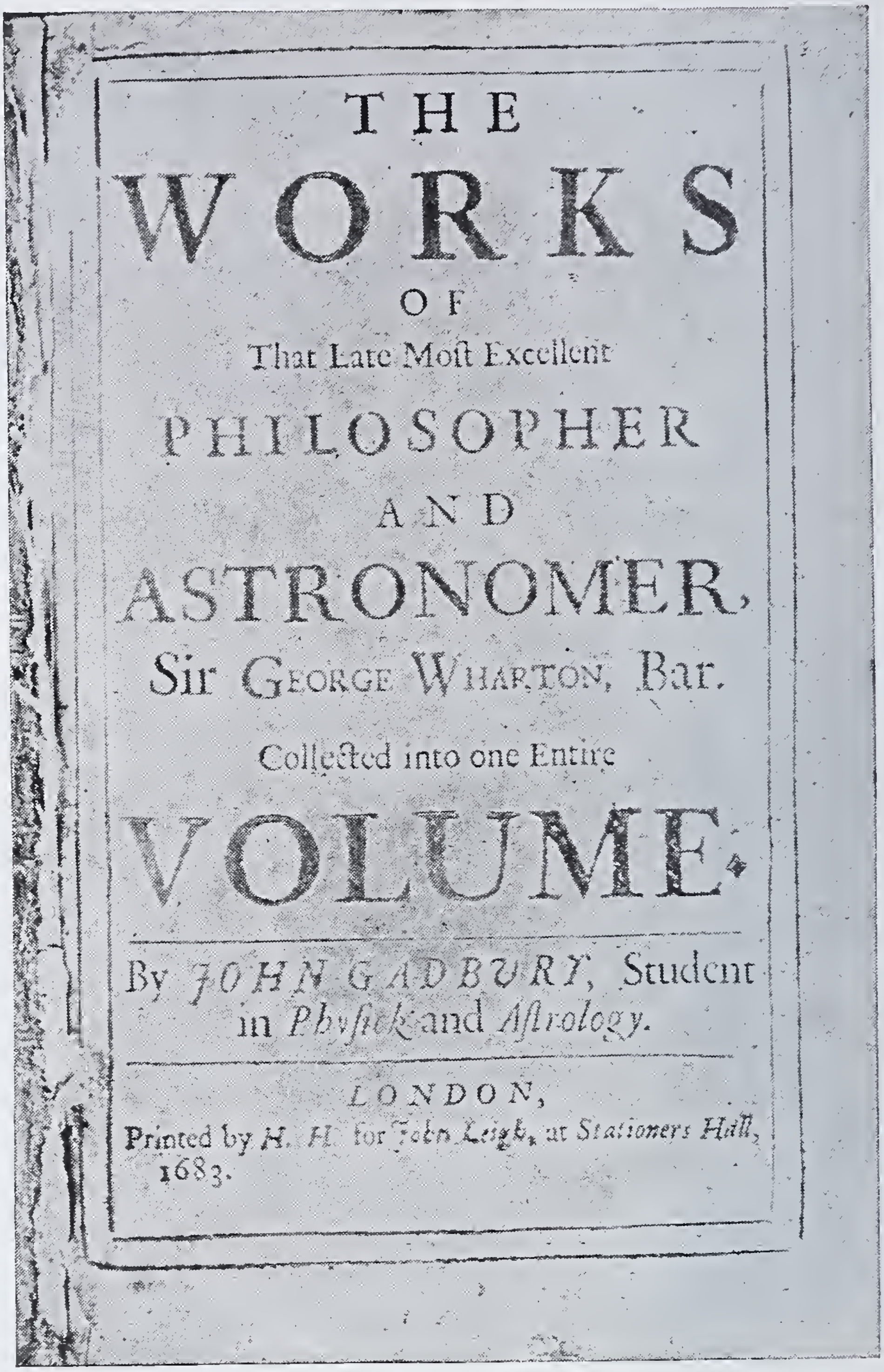
The name of Jehovah is divided into seventy explanatory names which are called "Schemhamphoras," or the name explained. The art of explaining these names and finding therein the keys of universal science is called the *claviculæ* of Solomon. The traditions of magic declare that the possessor of the clavicules of Solomon can converse with all orders of spirits and has power over all natural forces.

READING THE STARS

Astrology. Astrology, alchemy, and perpetual motion were banished for a time to the limbo of discredited quests. Alchemy has come back in a modern form in connection with the newer atomic theories. Astrology, which had never quite disappeared, is now reinstated in polite society through the medium of what we are pleased to call the newspaper. It had its origin in that cradle of civilization known as Mesopotamia. It developed coincidently with astronomy and rose to the dignity of a quasiscience at one time, and in medieval times the court astrologer was just as necessary as the court jester, and just as reliable, if the truth were known.

Charles the Wise (?), who reigned in France in the fourteenth century, had firm faith in astrology and had a court astrologer whose

sworn duty was to tell the King what was going to happen so that the King might take measures to prevent it from happening. What an opportunity for a clever individual! With the exercise of a little ambiguity in prophecies the astrologer stood to win every time,


THE WORKS OF That Late Most Excellent PHILOSOPHER AND ASTRONOMER, Sir GEORGE WHARTON, Bar. Collected into one Entire VOLUME. By JOHN GADBURY, Student in Physick and Astrology. LONDON, Printed by H. H. for John Leigh, at Stationers Hall, 1683.

Title Page of Astrological Work of the 17th Century

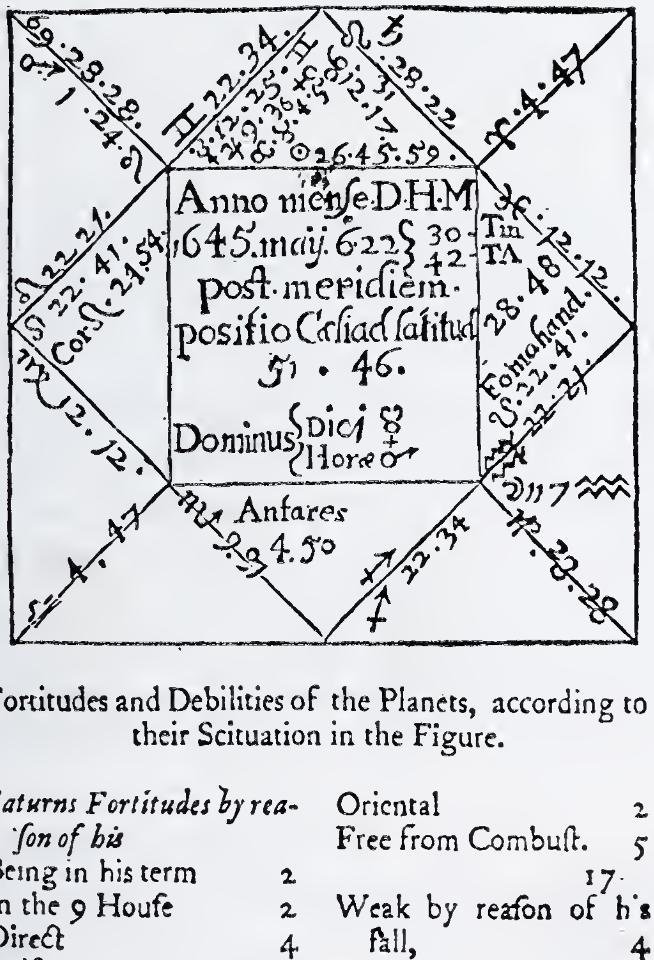
for if he foretold disaster and it came, fate was inexorable; if it did not come, it must have been averted by the measures which his royal master put into effect by reason of his timely warning.

Rudolph of Bohemia, the sixteenth century collector of fakers and charlatans, had faith in astrology, but unfortunately for him and fortunately for the world, the astrologers whom he selected, Tycho

Brahe and John Kepler, turned out to be two world-famous astronomers. Both of these men are said to have cast horoscopes as a side line. A graphic representation of a horoscope looks like a geometrical theorem gone cuckoo.

The most celebrated astrologer of all time, without a doubt, was Michel de Notre Dame, more generally known by his Latinized name, Nostradamus. He has been called the King of Astrologers. Like

A Cœleſtial Scheme, or Figure, ſetting forth exactly the true poſition and ſtate of the Heavens at the time His Majeſty began his March.



Fortitudes and Debilities of the Planets, according to their Scituation in the Figure.

Saturns Fortitudes by reaſon of his		Oriental	2
		Free from Combuſt.	5
Being in his term	2		17
In the 9 Houſe	2	Weak by reaſon of his	
Direct	4	fall,	4
Swift	2		
		P 3	*Jupiters*

Example of a Horoscope from an Old Astrological Work

other astrologers he made many prophecies and like them they were couched in such enigmatic terms that their meaning was not quite clear until after their fulfillment. The prophecies of Nostradamus are said to extend to the year 3797 A. D. It would be interesting for someone to search through his works and see what he had to say of world history during the period from 1914 to 1918.

It was in this medieval astrological period that the signs of the zodiac came to be associated with the external and internal environ-

ment of man as illustrated in the almanacs. According to the astrologers the sign under which one was born makes a lot of difference in his or her career. It helps a lot to explain where the "poor fish" originate, and why some people are "crabs" and others "throw the bull." Why should we call ourselves civilized when modern newspapers carry paid astrologers on their staffs to interpret planetary influences for their readers, and radiobroadcasting stations answer letters and questions through the power of a medium with a crystal ball?

ROSICRUCIANISM

Rosicrucianism is one of the great mysteries among secret doctrines. The Rosicrucians have been linked with the alchemists, with the Freemasons, and with the powers of darkness. Heckethorn in *Secret Societies of All Ages and Countries* says:

> "A halo of poetic splendor surrounds the Order of the Rosicrucians; the magic lights of fancy play around their graceful day dreams; while the mystery in which they shrouded themselves lends additional attraction to their history. But their brilliancy was that of a meteor. It just flashed across the realms of imagination and intellect, and vanished forever; not, however, without leaving behind some permanent and lovely traces of its hasty passage. . . . Poetry and romance are deeply indebted to the Rosicrucians for many a fancy creation. The literature of every European country contains hundreds of pleasing fictions whose machinery has been borrowed from their pleasing system of philosophy, though that itself has passed away."

The literature pertaining to the Rosicrucians is a bewildering mass of contradictions and inconsistencies. Several histories of the order have been written in recent years, but these are diametrically in opposition to each other in many points. Even the origin of the name is in doubt. The first and most obvious derivation is the one which attributes it to the alleged founder of the order, Christian Rosenkreuz. The second theory is that it is derived from the Latin *Ros,* dew, and *Crux,* cross. The argument in favor of this latter view is represented by the following quotation:

> "Of all natural bodies, dew was deemed the most powerful dissolvent of gold; and the cross in chemical language was equivalent to light, because the figure of a cross exhibits at the same time the three letters of which the word lux, meaning light, is compounded."

The third derivation deduces the term from *Rosa,* rose, and *crux,* cross. This is upheld by authoritative documents of the Society in which the members are called *Fratres Rosatæ Crucis.* An early document concerning this strange and mysterious society was published anonymously in Strasbourg in 1616, and was called *The Chemical Nuptials of Christian Rosenkreuz* (*Chymische Hochzeit, Christiani Rosenkreuz*).

It may be that the rose was adopted as the emblem of silence or secrecy, a symbolism which first appeared in Germany where the rose was portrayed on the ceiling of the banquet hall or council chamber to warn the guests or members against the repetition of what was heard beneath it. Among the Romans the white rose was especially dedicated to silence, and our expression "sub rosa" was an inviolable pledge to a Roman.

The Crux ansata (♀), which dates from Egyptian times, is a hierogram in which are combined the outlines of the cross and the rose, according to some authorities, and there is no doubt that this symbol possessed an arcane meaning in Rosicrucian literature.

We must not attach too much importance to symbolism and its inferential interpretations. Martin Luther, the reformer, had as a symbol a cross-crowned heart rising from the centre of an open rose, but no one has associated his name with Rosicrucianism.

The earliest document dealing with the Rosicrucians was called *Confessio Fraternitates R. C.,* which appeared in 1615. The full title of this work was "The Fame of the Fraternity of the Meritorius Order of the Rosy Cross," and it was addressed to the rulers of Europe. These mystical documents are not only difficult to interpret on account of their allegorical form, but contain strange symbols or characters which have not been deciphered. Was there really at any time a genuine secret fraternity of Rosicrucians, such as is described in Bulwer's interesting story of the occult, *Zanoni?* Bulwer probably received the inspiration for this tale from Eliphas Levi, with whom he was acquainted. If there was such an order, what was its real history? What powers did its members possess, and what has become of it? The accounts of the organization are enveloped in a mysterious halo of uncertainty. The accidental discovery of a secret sepulchre in the shape of a septagonal underground vault illuminated by a perpetual light, a limited number of members whose occult powers are unlimited, but whose idealism and purity of purpose restrain them from the improper use of such powers—these

almost melodramatic factors have invested the name Rosicrucianism with a glamour and a fascination which is well nigh irresistible. The lack of definite knowledge may be argued as a point in favor of the reality of such an order. We shall leave the question open.

Divination in General. A book of comparatively recent origin upon the subject of magic has the following paragraph in the introduction to divination:

DIVINATION

> "The circle of each of the physical sciences is surrounded with a fringe of light, easy and pleasing experiments which in themselves are exceedingly trivial, but are as so many thresholds of the deep things of knowledge, and are to be valued for that which they lead to, and not for what they are. The profundities of esoteric science have also their light fantastic borderland where the tyro may amuse himself, and where the vacuous interest of the modern *dame de societé,* who describes herself as 'very occult,' finds sufficient nourishment to sustain a shallow and sentimental interest in the mysteries of psychic force. . . . Considerable futility is mixed up with divination; it is essentially trivial in character; in itself it can be productive of no valuable results; the student of discrimination and sense will not squander his time and his powers on the little marvels of magic art; he will win entrance into the larger field of achievement."

The word divination is occasionally used in a broad, philosophical sense which places a different complexion upon it. Its significance is extended till it includes the sublime dream of astrology, spiritual visions, and the gift of inspired prophecy. According to the vulgar meaning of the term, to divine is to conjecture what we do not know, says Levi, but its true significance is ineffable in its sublimity.

Let us take these up in alphabetical arrangement and consider them concisely, for there is a long list of them.

Aeromancy. This is the art of divination by means of phenomena of the air. It is also called *meteoromancy.* The term is sometimes used to denote the practice of forecasting changes in the weather.

Alectoromancy or *Alectryomancy* is the art of divination by means of the cock or rooster. Chanticleer has always been credited with the ability to rout the hosts of darkness by his crow. In this form of forecasting the letters of the alphabet are traced upon the ground in squares within a circle, a grain of corn is placed upon each letter and a cock turned loose to feed. The order in which the let-

ters are picked up are noted and the letters are then formed into words or used as initial letters of some portentous message.

Aleuromancy is a method of divination by meal or flour, practiced for many centuries. Letters, words, and phrases are written on strips or squares of parchment or paper and mixed with meal or flour, which is subsequently made into a dough. A portion of this unbaked dough is then taken and soaked in water, the paper strips removed, and the message interpreted.

Alphitomancy is also a divination by means of meal. In this case barley meal was used. This was mixed with salt and milk without leaven, baked in the ashes of the hearth in a grease-soaked paper and finally removed and rubbed with vervain. This hard, concrete-like mass was then broken into fragments which were administered to those suspected of having committed a certain crime. Those who could swallow a lump of this material without any lubricating liquid were dismissed as guiltless. Those who choked or strangled or who were unable to swallow it were adjudged guilty.

Amniomancy was a form of divination practiced by the Greeks with the caul of a new-born child. Omens were drawn from the texture and color of the membrane.

Anthropomancy was a gruesome form of prophecy based upon the examination of the entrails of a sacrificed human being. This practice is of extreme antiquity and was mentioned by Herodotus.

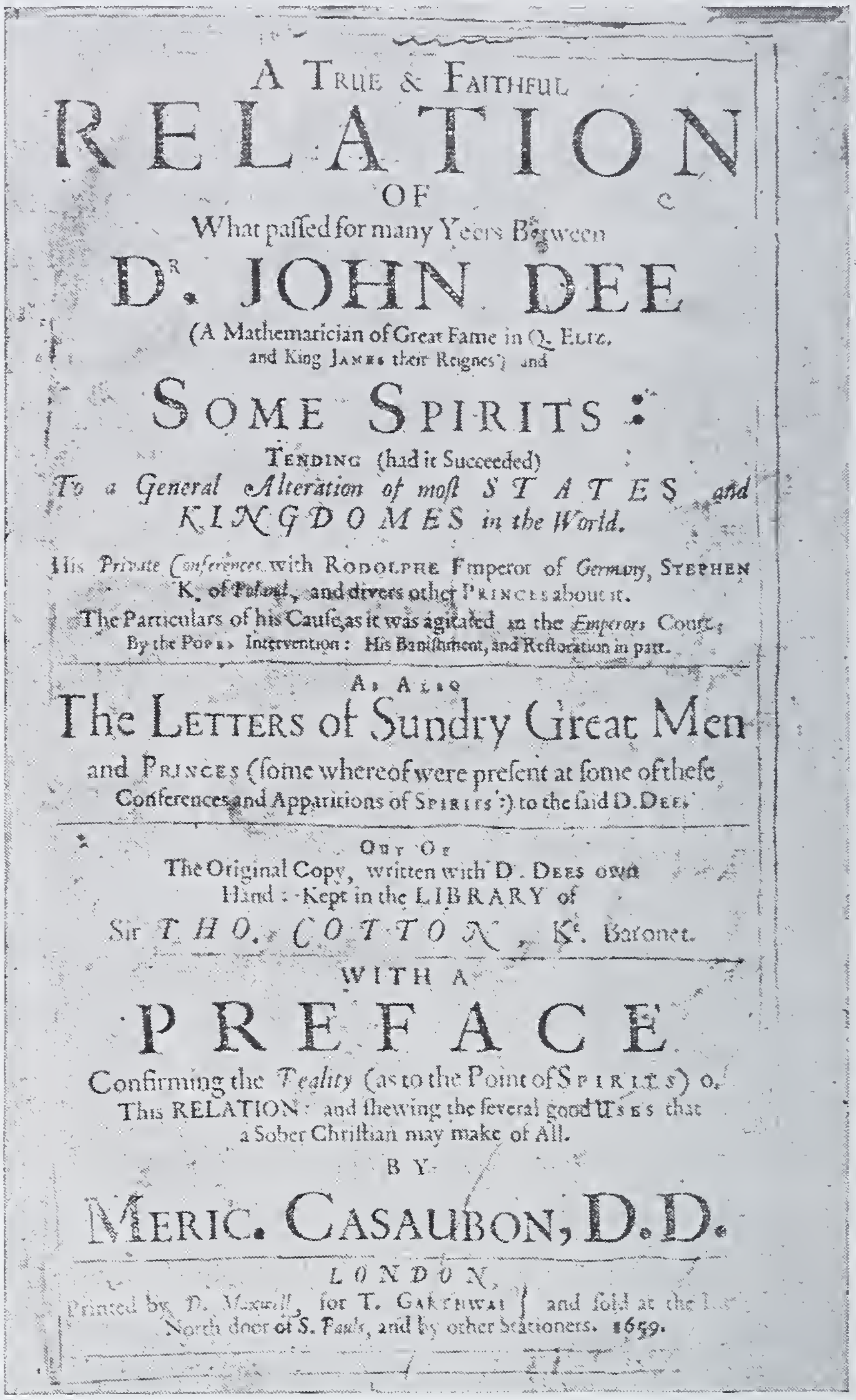
Arithomancy or *Arithmancy* depends for its efficacy upon the mystical properties of numbers. It is known as the science of esoteric mathematics and also dates from a very early period. The *Chaldean Oracles of Zoroaster* is an ancient work on that subject. Even today many people have what they call "lucky numbers." The only real lucky number of modern times is the telephone number that you get correctly the first time.

Astragalomancy. This is a form of divination by means of a pair of dice which may be cast singly or in doubles. Alphabetical characters are arbitrarily assigned to the numbers and the results of a number of casts interpreted as in other forms of divination when letters are selected.

Axinomancy is an ancient kind of divination for the detection of crime, in which an axe is used. There were several methods of applying this method, all of which were equally unreliable.

Belomancy. An ancient form of divination by arrows or darts, practiced by the Babylonians, Scythans, Arabians, and other ancient peoples.

Bibliomancy, also called *Sortes Biblicæ* or *Sortiariæ.* Several forms of divination were practiced with the Bible. In one of these the book was opened with a golden pin and an omen was drawn from the first passage which presented itself. This method plays an important part in Tennyson's poem of Enoch Arden. In another


A TRUE & FAITHFUL
RELATION
OF
What passed for many Yeers Between
D^R. JOHN DEE
(A Mathematician of Great Fame in Q. ELIZ. and King JAMES their Reignes) and
SOME SPIRITS:
TENDING (had it Succeeded)
To a General Alteration of most STATES and KINGDOMES in the World.
His Private Conferences with RODOLPHE Emperor of Germany, STEPHEN K. of Poland, and divers other PRINCES about it.
The Particulars of his Cause, as it was agitated in the Emperors Court; By the POPES Intervention: His Banishment, and Restoration in part.
AS ALSO
The LETTERS of Sundry Great Men
and PRINCES (some whereof were present at some of these Conferences and Apparitions of SPIRITS:) to the said D. DEE.
OUT OF
The Original Copy, written with D. DEES own Hand: Kept in the LIBRARY of
Sir THO. COTTON, K^t. Baronet.
WITH A
PREFACE
Confirming the Reality (as to the Point of SPIRITS) of This RELATION: and shewing the several good USES that a Sober Christian may make of All.
BY
MERIC. CASAUBON, D.D.
LONDON,
Printed by D. Maxwell, for T. Garthwait, and sold at the North door of S. Pauls, and by other Stationers. 1659.

Title Page of Work by John Dee, the Famous English Alchemist and Occultist

form a large Bible was placed on one side of an old-fashioned balance. The person suspected of crime or of black magic was placed on the other side. If he outweighed the Bible he was innocent; if not, he was guilty.

Capnomancy. This was a form of divination by means of smoke or vapor. In one form certain seeds and drugs were cast upon a fire

and the form assumed by the smoke wreaths interpreted. In the other the operator inhaled the smoke and was inspired thereby with the gift of prophecy.

Cartomancy is the form of fortune telling or divination by means of playing cards, and is too well known to require description.

Cephalonomancy. Lighted coals were placed upon the head of a donkey. Prayers were recited, and the names of suspected persons mentioned at random. The one whose name was mentioned at the moment when the ass brayed with pain, was adjudged guilty.

Dactyliomancy. This is divination by means of a finger ring. It was much used in olden times and played an important part in the trial of the conspirators Patricius and Hilarius in connection with the successor to Emperor Valens. There are certain rings known as constellated rings, which require much ceremonial in connection with their use.

Gastromancy. This is literally "divination from the belly," and is usually applied to ventriloquism, although belly-shaped glasses filled with water have also been used in a manner similar to that of the crystal ball.

Geomancy. This is divination by means of the earth. Geographical position, configuration or even the use of earth or dust itself are variant forms of this variety of divination.

Gyromancy. This is practiced by a person walking in a circle until he falls from dizziness, the direction of the fall being significant.

Hippomancy. This is based upon the use of white horses. (Perhaps the old notion that every time one saw a red-headed girl a white horse would be visible was based on this same superstition.) This was originally a Celtic rite, and the sacred horses were kept in consecrated forests and fed at the public expense.

Hydromancy. This is a branch of clairvoyance in which water is used in various ways as the divining medium.

Ichthyomancy is a form in which an inspection of fish entrails affords the necessary data for prognostication.

Lampodomancy involves the inspection of the flickering flame of a lamp; not an electric lamp, however.

Lithomancy is divination by stones. Certain semi-precious stones, such as the amethyst, were especially gifted as media for this purpose. It is not generally known that the word amethyst is derived from sources indicating its protective power against the effect of wine.

Margaritomancy requires pearls for its consummation.

Myomancy. In this form of divination mice are employed. It is probably one of the most ancient forms, for in the Old Testament Isaiah classes mice among the abominable things of the idolators.

Onomancy or *Onomatomancy* is the use of names in predicting future happenings. This form is often used by school boys and girls for the purpose of determining the feelings of one of the opposite sex.

Onychomancy. This is not as trivial as one might suppose, and the method is distinguished by being associated with the power of the angel Uriel. Upon the nails of the right hand of a young boy or young girl is placed some fixed oil or wax and some pigment, such as blacking. The anointed nails are turned toward the sun and observed by the seer, who was required to face the east for some kinds of divinations, while in other cases the seer must face the south or the west.

Oömancy requires the use of eggs. It is usually practiced by opening an egg into a glass of water and observing the form which it assumes.

Parthenomancy. This was a form of divination in which a virgin or young girl was employed.

Pyromancy is another very ancient form in which flame or fire affords the needed factor for occult judgment.

Rhabdomancy, also called *Bletonism* or *Dousing,* is the use of the forked witch hazel branch, commonly called the divining rod, which is employed, even today, in locating subterranean streams of water or for finding hidden treasure or valuable mineral deposits.

Sciamancy is really a form of necromancy or evocation of the shades of the dead, which has already been considered.

Spodanomancy or *Spodomancy* is divination by means of ashes scattered in an open place and written upon by the use of a finger. After exposure over night any letters that remain legible, of the question that has been written, are utilized in the interpretation of the answer to the question.

Sycomancy must have been the earliest form of divination, for fig leaves are employed as the oracles.

Theomancy is a form of cabalism and is concerned with the use of sacred names.

A conjuror is etymologically one who is bound by an oath, literally, a conspirator. The common use of the term places the conjuror in the same class as the enchanter or the magician. The conjuror

also is grouped with the class of diviners, or those who foretell the future by various means. An augur is literally a bird conjuror, from *avis,* bird, and *gur,* a chatterer. The augur was an important functionary and official in the days of the Roman Empire. There were sixteen of them in the time of Julius Caesar. They wore togas with broad purple borders and each carried a rod called a *lituus,* and was accompanied by the sacred bird. The haruspex was another soothsayer of Roman times who exercised his art by the inspection of entrails.

The golem was an artificial human being, specially constructed and later endowed with life. The golem plays a part in Hebrew occultism, and often turned out to be a sort of Frankenstein.

In this very complete list, comprising nearly two-score forms of divination, no mention has been made of the use of tea leaves or coffee grounds, both of which practices, while possessing great popularity, seem not to have found their way into the formal literature of the subject.

The Ouija Board or planchette must not be overlooked in the consideration of popular forms of divination. "Ouija" is a trade name for the device known as planchette (literally a small board), and means to answer "yes." It is a heart-shaped or triangular board mounted on three supports, of which two are easily moving coasters or wheels, and the third is a pointer or pencil point. The original planchette traces letters or sentences by subconscious movements of the operator and thus answers questions or transmits messages. The Ouija Board is provided with letters and numerals and the subconscious movements of the operator cause the spelling out, letter by letter, of answers and messages.

Ordeal by poison is a primitive form of sorcery in which the guilt or innocence of a suspected person is determined by the administration of a poisonous potion. If the suspect recovers, he or she is innocent; if death ensues, the suspected person is guilty. Calabar bean, a poisonous seed containing a valuable principle known as eserine or physostigmine, much used by ophthalmologists, was originally used by certain African tribes as an ordeal substance, and the synonym "ordeal bean" is still applied to it.

Other forms of ordeal are known. In Burma, suits between natives are still determined by the plaintiff and defendant each being furnished with a candle. These are equal in size and weight and both are lighted simultaneously. The one whose candle burns the

longest is adjudged the victor in the suit. This method might be used by the United States Senate to determine the eligibility of rival contestants, with great economy of public funds and almost equal certainty of justice, as compared with present procedures.

The *Encyclopedia Britannica* contains a comprehensive article upon the subject of ordeals, in which many other methods are described.

Palmistry, which is sometimes called Chiromancy or Chirognomy, is divination by the lines and lineaments of the hand. One who practices this art is called a "chirosophist."

PALMISTRY, PHRENOLOGY PHYSIOGNOMY

Phrenology, or the evaluation of the faculties of the individual by study of the shape of the head, originated much later than most other forms of divination, as it first appeared toward the close of the eighteenth century. The system was founded by Dr. Franz Joseph Gall, a Viennese physician, and was extended and promulgated by his pupil and associate, Dr. Spurzheim, to whom we owe the phrenological charts and faculties so frequently seen. Phrenologists often advertise their accomplishments with the slogan, "We can read your head like a book." Modern anatomy, physiology, and psychology have refuted the extravagant claims of phrenologists.

Physiognomy, which is sometimes called Metoposcopy, is a form of divination kindred to phrenology, in which the character and disposition of the individual is discovered by a study of the features and lines of the face. This is not infallible as a guide to character. There are photographs in the Rogue's Gallery of individuals who look like anything but the criminals which they are.

We could ramble on indefinitely, finding new evidences of human superstition and credulity on every hand, but we have gone far enough to show the widespread extent to which occultism has developed. Dr. David Starr Jordan coined a word more than twenty-five years ago which, while it has not found its way into general literature, certainly fills a need in connection with a discussion of this kind. It is the word "sciosophy," and means "systematized ignorance."

Giordano Bruno, the Florentine scientist who was burned alive by the ecclesiastic sciophists of his time, said of ignorance: "It is the most delightful science in the world because it is acquired without labor or pains and keeps the mind from melancholy."

Do not think for a moment that all of these occult practices are of the past. "Powwowing" is still practiced in some parts of Pennsylvania, and witchcraft is by no means a despised or neglected art. The dream book still has its votaries. Publishing houses still issue books giving dogmatic and detailed directions for becoming an adept in various branches of occultism. Much of the patronage of these false leaders comes from the credulous among the uneducated, but even among the so-called "intelligentsia" are found victims of these delusions, reminding us of an old Arab proverb which says: "When the learned man errs, he errs with a learned error."

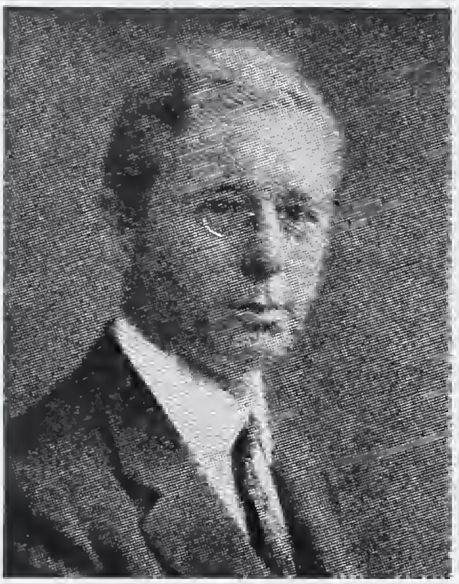
In conclusion let me say in the words of one of our popular cartoonists, "Most of it's the bunk."

EPOCHS AND EPOCH MAKERS OF MEDICINE

Horatio C. Wood, Jr., M. D.

Professor of Materia Medica at the Philadelphia College of Pharmacy and Science

THE WORD epoch is often applied, somewhat loosely, to any event of more than ordinary importance in the development of a science. With such a definition the title of this lecture would become ridiculous because even a mere list of the great discoveries of medicine could not be confined within the limits of a single lecture. I use the word, however, in the stricter meaning of "an event in the progress of history from which succeeding years are counted."



Horatio C. Wood, Jr., M. D.

From a medical viewpoint the 30 centuries of history divide themselves, almost naturally, into five eras which may be approximately dated as follows:

1. Sacerdotal or Premedical, from dawn of history to 200 B. C.
2. Speculative Medicine, from 400 B. C. to 200 A. D.
3. Dogmatic Medicine, from 200 to 1600 A. D.
4. Early Scientific Medicine, from 1600 to 1850.
5. Modern Medicine, from 1850 to present time.

Practically all races of primitive peoples have attributed disease to the machinations of evil spirits. It is only natural, therefore, that in the early periods of civilization treatment of the sick should have been in the hands of the priesthood. At first this duty appears to have been assigned indiscriminately to any member of the sacerdotal class, but when civilization began to become more complex, there was manifest a tendency towards specialization, and distinct groups of priests were especially charged with the exorcism of the demons of disease. Thus, among the ancient Greeks this function belonged to the priests of Aesculapius, the son of Apollo; while in Egypt it was assigned to those who were consecrated to the worship of Osiris.

Gradually, by the accumulation of experience, these groups of

priests acquired some knowledge of the beneficial effects of material agencies, such as certain herbs, as an aid to the religious ceremonies which were the important part of their treatment.

It seems probable that Moses acquired the knowledge of hygiene which is so manifest in the laws that he gave to the children of Israel from his early training as a priest of Osiris.

HIPPOCRATIC ERA

The Greeks were never a people of strong religious instinct, and, despite the wealth of imagination shown in their theological myths, they do not appear to have taken their religion with the same seriousness as, for example, did the Semitic peoples. It is not surprising, therefore, that comparatively early in Grecian development there grew up a guild of medical practitioners—called Asclepiadæ—who were not members of the priestly class, although they did mix more or less theurgic therapy with their drugs. The most famous of this group was Hippocrates II, commonly called "The Great." He was born about 460 B. C., one of a long line of hereditary practitioners of the healing art. Recognized even by his contemporaries as an intellectual giant, he exerted a most potent and salutary influence on medical thought; so much so, that he is commonly referred to as "The Father of Medicine." While not the first physician whose name has come down to us, he nevertheless deserves the title because, more than any other single man, he was responsible for the establishment of the medical art by rescuing it from the shackles of priestly superstition.

Hippocrates and his contemporaries bothered themselves but little with what we now call the medical sciences. He observed and reported on the manifestations or symptoms of disease, theorizing on their prognostic importance, but displays very little curiosity as to the mode of their production. He made some anatomical studies, but of physiology he remains almost completely silent. His great contribution to medicine was the doctrine, still held today, that the art of medicine should be based on observation and reasoning from experience, rather than the application of theories evolved from the inner consciousness.

In the centuries immediately succeeding Hippocrates, largely under the influence of philosophers like Plato and Aristotle, physicians began to interest themselves in how the body functions, but their ideas were derived from conjecture rather than observation. The result of this method was an extraordinary diversity of opinion

and the consequent formation of a large number of "schools" of medical practice.

Long after Greece had lost her political supremacy she still retained her intellectual dominance; for the science, like the art, of Rome was largely a borrowed culture. The post-hippocratic era of speculative medicine lasted through the rise and decline of Grecian greatness and about the time of the height of the Roman glory underwent a sort of crystallization, the taking on of a fixed form. This change was largely due to one man who, like so many of the Roman physicians of the time, was of Greek extraction.

GALENIC ERA

The foremost character produced in this period was Claudius Galen. Born 141 A. D., in the city of Pergamus in Asia Minor, he was thoroughly educated both in the humanities and in the medical lore of his day, first at his native town, then in Smyrna and finally at Alexandria, where gathered the most famous teachers of ancient times. At the age of 34 he went to Rome, where he resided for the remainder of his life, save for the time spent in traveling. Here he acquired such fame that he was invited by the Emperor Marcus Aurelius to accompany him in one of his military expeditions, an invitation which he declined.

Galen was a most versatile and prolific writer, with a supreme confidence in his own judgment and a consequent contempt for those who differed with him. He did considerable real investigation in anatomy but even here did not hesitate to surmise what he could not see. His physiological and pathological writings, while voluminous, seem to be founded more on what he thought ought to be than on what really is.

During his lifetime, and for some years after, Galen had many opponents, but as Europe gradually sank into the mental stagnation of the dark ages his writings came more and more to be regarded almost in the light of divine revelation and for more than a thousand years completely dominated medical thought.

The same spirit held the scientists then as now governs so many of our theologians. Authority, not reason, was the guide men followed. To doubt the teachings of the medical classics, such as the writings of Galen, was to court both scientific and social ostracism, and few there were with sufficient temerity to undertake the task of attacking theory with fact. The conditions which made an intellectual martyr of Gallileo and cast Roger Bacon into prison, do not create an atmosphere in which science is likely to flourish.

The progress of the art of medicine must always be largely conditioned on the status of its fundamental sciences. The current hypotheses concerning bodily functions in health and the causes of the deviations from the normal which we call disease, must, to a large extent, determine the accepted method of treatment. When physiology is based upon a collection of fancies instead of an aggregation of facts, no great advance may be expected; a polluted fount does not give rise to a healthful stream. Small wonder that by the Middle Ages the healing art had reached a stage of arrested development. When to ask a question was to commit a crime, no progress was possible. The intellectual renaissance, which occurred about the time of the discovery of America, was slow to affect medical thought. While from the New World there came a few valuable drugs, and there was real progress in the treatment of one or two diseases, notably malaria fever, as a whole the fifteenth century represents the blackest period of medical ignorance.

But the night is the darkest before the dawn, and, in the year 1578 there was born in England one who was destined to give a new birth both to medical science and practice. If Hippocrates deserves the title of "Father of Medicine," then William Harvey may justly claim the distinction of "Father of Modern Medicine," for it was on his solution of the incomprehensible problem of the circulation of the blood that is founded the pillar on which rests all our present concepts of physiology.

In order to understand the revolutionary nature of the ideas put forth by Harvey, it is necessary to briefly review the current tenets concerning the distribution of the blood which were, with only slight modification, those taught by Galen.

It is scarcely accurate to speak of Galen's theory of the circulation of the blood because he had no concept of a continuous flow in a circle, which is the basic idea conveyed by the term circulation. While it is difficult to apprehend all the details of his notion, in a general way it seems to have been about as follows: There are two sorts of blood in the body, one carrying the grosser, nutritive, elements to the tissues; the other supplying "vital spirits." The nutritive blood is manufactured in the liver from the digested food received from the intestines; it is distributed through the veins to various parts of the body. The veins start from the liver and run to all the organs including the lungs and the heart. He likens this system of distribution to the irrigating canals in a garden and calls attention to a

wonderful provision of nature by which the different organs "should neither lack a sufficient quantity nor be overloaded at any time with an excessive supply"; obviously there is nothing here to suggest any idea of a circulation.

The vital spirit (apparently a similar concept to the "breath of life" used in the Bible) is concocted in the heart from the air taken into the lungs. The heart by its dilation draws the air and blood from the lungs; he says "as the bellows of a blacksmith draw in air when they expand, as the flame of the lamp draws oil through the wick, or as the magnet attracts iron, so it is with the heart; it possesses in itself an inherent power of attraction." The vitalized blood is carried to the distant parts by the arteries, which by a similar expansion suck the blood from the heart. As his anatomical observations had shown him that the artery from the lungs runs to the right side of the heart, while that going to the rest of the body comes from the left side, it was necessary to explain how the blood gets from the right to the left heart. This he did by imagining the existence of minute openings in the septum—or wall between the two cardiac chambers (see Fig. 2).

Galen believed that the blood running to the various organs was just enough to fulfill their nutritional requirements and that it, all of it, whether the venous blood or the vital spirits, was consumed by the tissues; he had no idea of any return flow either to the heart or to the lungs.

The Galenic dogmas were accepted, almost without question, for more than 1300 years, but towards the end of the sixteenth century anatomists began to realize that there were certain facts which could not be explained by his theory. In 1543 Andreas Vesalius, then Professor of Anatomy at the great University of Padua, published a book on the anatomy of the heart in which he stated that he could not see any openings through the septum; while it seems apparent that he did not believe there were any, he did not have the courage to actually deny the doctrine, in the face of its universal acceptance, but merely says that he is "in great doubt as to this function of the heart."

At this time there was living a man, named Michael Servetus, remarkable for his heretical character, both theologically and medically. How extraordinarily heterodox he was is suggested by the fact that he was condemned to death by the followers both of the Pope and of John Calvin. The latter, however, had the advantage

of possessing his body and actually burned him at the stake, while the papal party were perforce satisfied with burning his effigy. In one of his theological disquisitions—for it must be remembered that men then mixed their theology and medicine in a manner which seems to us today to be strangely naïve—Servetus showed that there really were no openings in the septum between the two sides of the heart, and that Galen's explanation of how the blood got from the right to the left heart was evidently untenable. This was one of the sins for which he paid with his life. He maintained that the blood, to get from the right side of the heart to the left, must pass through the lungs, a view which we today know is correct. He did not appear, however, to have any notion of a continuous flow in a circle, that is circulation. Moreover, as all his books, which could be found, were burned with him in 1553, his doctrines had little effect upon general opinion.

It is possible, however, that they bore fruit through their influence on Colombo. The latter, originally an apothecary, took up the study of medicine and became first assistant and then successor to Vesalius. In a posthumous work, published in 1559, he categorically denies the possibility of blood passing through the cardiac septum and clearly intimates some idea of a pulmonary circulation. He accepted, however, the rest of the theory of Galen.

HARVEIAN ERA

Such was the general status in the year 1578, when William Harvey was born. He was the son of a man of some local importance who had been successively Alderman and Mayor of Folkestone. His early education was received at an institution, of which he later became the most powerful patron, called Caius College. Subsequently, he went to the University of Cambridge, and from there to Padua in Italy, which was at that time the most famous seat of medical learning in the world.

In 1602 he returned to England to engage in the practice of medicine, and became Professor of Anatomy in the College of Physicians in 1615. Three years later he was appointed Physician Extraordinary to the Court of King James, and later became the personal physician and friend of the unfortunate son of that monarch known in history as Charles I.

After the overthrow of the royal power by Cromwell, being then a man well on towards seventy years and afflicted with gout, he retired from public life and lived with his brothers, who were suc-

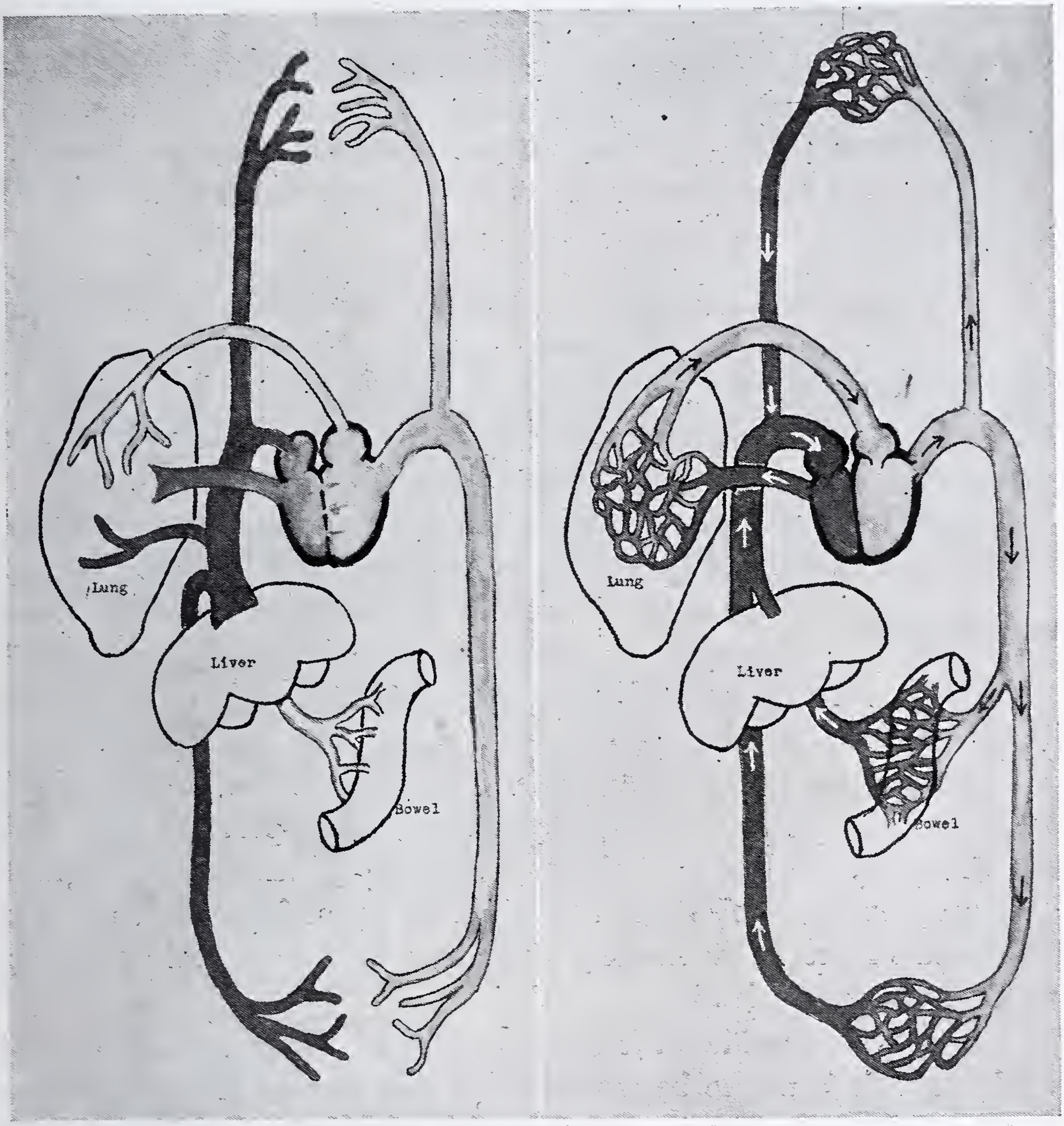
cessful merchants in London, where he died of apoplexy in his eightieth year.

There is strong evidence that Harvey taught his students the novel doctrine of the circulation of the blood almost from the beginning of his work as Professor of Anatomy, but it was not until 1628

FIG. 1
William Harvey

that he made public his heretical and revolutionizing theory in a pamphlet that was printed in Germany at Frankfort-on-the-Main. Perhaps the intervening dozen years had been used by him to further assure himself of the correctness of his views, but it seems to me more probable that the delay was due to his recognition of the storm of criticism and vilification which was sure to follow such an impious flouting of the authority of the ancients; by 1628 he was established, not only as a successful practitioner and respected teacher, but also as a favorite intimate of royalty. Among the more kindly explanations of his conduct which were offered by his orthodox an-

tagonists, was that he was demented. While in view of his professional and political prominence, these attacks did not altogether



A. B.

FIG. 2

A. Galen's concept of the distribution of the Blood. The nutritive blood comes from the Liver and is carried through the body by the veins; the "vital spirit" comes from the heart and is distributed through the arteries.

B. Harvey's theory of the circulation of the Blood. There is only one kind of blood, which is pumped by the heart, through the arteries, to the body and back through the veins, to the heart.

destroy his position in England, they did cause the loss of a great part of his private practice, which he seems never to have regained.

The fundamental differences of the Harveian concept from that of Galen are:

(1) That the essential activity of the heart is not a suction like a bellows, but an expellant power, like a force pump. (2) That there is no such thing as vital spirits, either in the heart or in the blood. (3) That the blood gets from the right to the left heart, not through imaginary openings in the wall between them, but by being driven through the lungs by the force of the right ventricle. (4) That the blood flow is a continuous one, always in the same direction, away from the heart, through the arteries, back to the heart through the veins.

The supreme significance of Harvey's work lies not merely in the fact that nearly all our present notions of physiology and pharmacology are built on his concept of the circulation, but chiefly in that he established for all time the dominance of observation and experiment as the primary factors of scientific progress.

Medicine had a sister, called Surgery; probably a twin sister, for the ancient Asclepiads seemed to have practiced both professions.

MODERN ERA

This sister, however, was held in distinctly lower esteem, even from the beginning; the very word "surgery" conveys something of disparagement for it is derived from two Greek words meaning "hand work." By the time of Galen, it was beginning to fall into marked disrepute. Galen himself makes some slight mention of certain operations, but appears to have held the actual performance of them as something beneath his dignity. Gradually surgery fell lower and lower in scientific society, until, in the Middle Ages, it was largely given over by the medical profession to the tonsorial profession.

When one considers the conditions under which operations were performed, it is not to be wondered at that men of fine sensibilities wanted little to do with it. Imagine the poor victim, held to the table by several stalwart assistants, while the barber-surgeon went ahead with his cutting and sawing, amid the pitiable shrieks and writhings of the suffering patient. When the cutting was over, the wound was seared with a red-hot iron or boiling oil. After this torture there remained a long and painful period of convalescence. Let me read a quotation from a letter, written by a physician to the great English surgeon John Hunter, towards the end of the eighteenth century. This physician, for some reason, required an amputation of his leg, and from it he learned how operations were viewed by the patient. A part of his letter is as follows:

> "Of the agony occasioned, I will say nothing. Suffering so great as I underwent cannot be expressed in words. . . . But the black whirlwind of emotion, the horror of great darkness and the sense of desertion by God and man, bordering close on despair, I can never forget however gladly I would do so. . . . I still recall with unwelcome vividness the twisting of the turniquet; the first incision; the fingering of the sawed bone; the sponge pressed on the flap; the stitching of the skin." *

In an address before the American Surgical Society, the late Dr. Warren of Boston, said of the suffering of the convalescent period:

> "The dread of pain was not confined to the operation, for in the early days, the after treatment was of the most torturing description. Every flap of skin, instead of being re-united, was cut away; every open wound was dressed as a sore, and every deep one plugged up with a tent, lest it should heal. Long tents were thrust into the wounds of the neck and cheek until the neck and head swelled enormously."

Life itself was almost too dearly purchased at such a price, and it is small wonder that patients not infrequently committed suicide rather than endure the horrors of an operation.

The tortures of the operating room were greatly mitigated by the introduction of surgical anæsthesia in 1847, but the sufferings of the convalescent period and the frightful mortality which followed surgical interference were not materially affected by this great boon. In the very best hospitals of Europe, after simple amputations, from forty per cent. and upwards of the patients died from the operation; one of the surgeons in Napoleon's army, Dr. Faure, reports that after the Battle of Fontenoy of three hundred amputations performed, only thirty patients survived. The great majority of these deaths were due to gangrene and other types of wound infections, which the surgeons were powerless to prevent or relieve because of their complete ignorance of their source.

The year 1927 marks the centennial of the birth of the man who blazed the way for prevention of wound infections and made possible modern surgery. Himself a practical surgeon, with large experience, his work was so intimately mingled with, and dependent on, the investigations of a group of laboratory scientists that it savors

*Quoted from Ashhurst, *Internat. Med. Mag.*, October, 1896.

of unjust discrimination to single out any one man as deserving of the glory of originating what is commonly called the germ theory of disease.

The beginning of this great discovery, which marks the opening of the era of modern medicine, had its roots back in the seventeenth century. As a preliminary necessity for the discovery of bacteria and their relation to disease was the compound microscope, for without this instrument it is obviously impossible to see those minute particles of living matter; so small are they that half a million of them would scarcely cover the head of a common pin. Probably the first man ever to see a bacterium was the Dutch dilettante scientist Anton Van Leeuwenhoeck, sometimes called the "Father of Microscopy," although not the inventor of the microscope. Although after he described these minute forms of life, they were the subject of much scientific curiosity and study, interest in them was purely academic and was confined for one hundred and fifty years almost exclusively to botanists.

At this stage there appears on the scene a French chemist, whose interest in the properties of the different forms of tartaric acid eventually led him to show that vinous fermentation was due to living organisms closely related to these botanic curiosities.

Louis J. Pasteur was born in the town of Dôle, in Eastern France, the son of a tanner, in the year 1822. He never studied medicine, but became Professor of Chemistry in the University of Strassburg in 1856, and subsequently at the Sorbonne in Paris. The year of his entrance into Strassburg is also noteworthy for the beginning of a series of publications dealing with the cause of the change of grape juice into wine and the subsequent spoiling and souring of the wine. He showed that these changes were due to the presence of microscopic vegetables, and that if the wine were heated it would keep indefinitely. He did not give any attention to the possibility of connecting these organisms with disease of either man or beast until after the work of one of his contemporaries had made such a hypothesis probable. Although not the originator, therefore, of the germ theory of disease, he subsequently made very valuable contributions to the development and establishment of this theory. He died in the year 1895, rich in the honors bestowed by his country and the world-wide recognition of a grateful humanity.

The first investigator to assign to bacteria a definite role in the causation of a disease appears to have been Casimir Joseph Davaine,

who was born in Saint Amand-les-Eaux, a village of Northern France whose hot springs were famous in the time of the Roman invasion. He graduated in medicine in Paris in 1837, but devoted his life chiefly to scientific research. In 1855 he described a peculiar microscopic rod-shaped body, which he found in the blood of sheep that had died of anthrax. At first he attached no significance to these corpuscles, but after the publication of Pasteur's work on the fermentation of wines the similarity in appearance of the growths described by Pasteur with those he had observed in anthrax suggested to his fertile mind the possibility of a causal relationship, and he undertook some experiments to determine the truth of this theory. In 1863 he published the results of experiments from which he drew the conclusion that these rod-shaped bacteria were the cause of that terrible plague, which has been, and still is, of such great economic importance in agricultural regions. This thought was almost as startling as would be the suggestion today that gravitational attraction was due to bacteria. It is not surprising, therefore, that the evidence he adduced in favor of his theory was not held sufficient by his contemporaries to justify its acceptance; and it was not until the German bacteriologist Robert Koch, by his more exacting methods, had demonstrated the truth of Davaine's hypothesis, that it was generally accepted.

While these revolutionizing ideas were exciting the scientific circles of France and Germany, an English surgeon was applying the work of these laboratory investigators to the practical benefit of humanity. As the centenary of his birth is so near at hand, I have thought it only just to speak a little more at length, both on the man and his achievements.

Joseph Lister was born of Quaker lineage, in the town of Upton, in Essex, England, April 5th, 1827. He was a gentle, kindly man, as widely loved for his attractive character as he was esteemed for his professional attainments. Fielding Garrison, in his *History of Medicine,* says of him: "The character of Lister is one of rare nobility. As the Quaker is the Puritan transposed into a softer and more grateful key, so his nature had those elements of sweetness which probably can come only out of strength." *

In 1860 Lister became Professor of Surgery in the University of Glasgow, and from then until his death in 1912 was universally

***History of Medicine,* 1921.

regarded as one of the foremost surgeons of England. To a man of his sympathetic character, the sight of the suffering in the Surgical Ward was a source of continual torment; intuitively he felt that there must be some way out of this maze of death and suffering. When he heard, in 1864, of Pasteur's discovery that sterilization of wine prevented its spoiling, the thought immediately came to his mind

FIG. 3

Joseph Lister

whether some analogous principle might not apply to wounds. Obviously one could not sterilize the seat of an operation by boiling the part, and so he turned to chemical substances which were known to destroy bacteria. After experimenting with several of these, he finally decided on carbolic acid as the most available disinfectant for the purpose. The technique as at first developed by him, called for

a continuous spray of a solution of carbolic acid over patient, operator and instruments. The first operation under this technique was performed in 1865, and the first publication of his results showed a reduction in the mortality of his own operations to about one-fourth of their previous number.

Like all innovations, his theories and methods had their detractors, but the work of Davaine, of Koch and of Pasteur had prepared the minds of the scientific world, and soon, as reports from other surgeons of similar successes under the Lister technique came pouring in, the medical world was shaken as by a hurricane, and when Lister visited Germany, in 1880, his travel was like the triumphant tour of a conqueror. He was a conqueror, greater than Alexander or Cæsar or Napoleon. Where these have left in their wake thousands of corpses, Lister's pathway is marked with hordes of living men and women. His native land recognized his achievements with a title of nobility; the only instance, I believe, where an English physician has been elevated to the peerage. Learned societies and institutions bestowed upon him all sorts of honors and degrees; and he lived to hear the unending plaudits of a grateful humanity and to realize that thousands upon thousands, yet unborn, were to owe their lives to his discovery.

The germ theory of disease is of no less importance to medicine than it is to surgery. Diphtheria, the dread scourge of childhood, was conquered years ago and the day is not far distant when it will be exterminated from the earth. Within the last few years a similar power has apparently been acquired over scarlet fever. Yellow fever, which, a few years ago, numbered its victims by the thousands, is a thing of the past. The Black Plague of medieval Europe which according to LaWall * caused in the thirteenth and fourteenth centuries the death of sixty million persons, is still endemic in Asia; but Europeans and Americans, by their knowledge of bacteriology are able to protect themselves against its ravages. Pneumonia and influenza, and a few other diseases still remain to be subdued, but I surmise that they too, in the not remote future, shall yield to our growing knowledge, and only gunmen and automobiles will be left to bring us to untimely graves.

What of the future? We of today are wont to look back on the practices of the ancients with mingled scorn and amusement but we

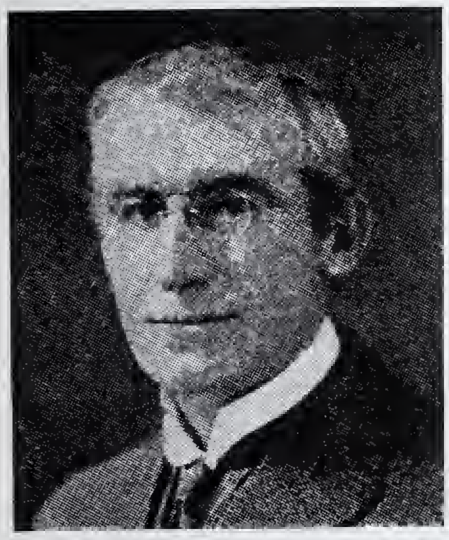
*_Four Thousand Years of Pharmacy_, 1927, p. 148.

may well take to ourselves the words of the prophet Elijah: "I am not better than my fathers." Let us not forget that we are building on the foundations they laid. Marvelous as has been the progress of medicine during the last century—unrivalled in any period of the world's history—yet it would have been impossible had we not been taught by Hippocrates the value of observation and by Harvey the necessity of experimentation; even from the Galenic era, although we may well avoid its mistake of blind adherence to accepted doctrines, we may learn, to our advantage, a due respect for the achievements of our predecessors.

THE STORY OF BURNT CLAY

By Professor J. W. Sturmer

THE AFFINITY which a small boy exhibits for mud is proverbial. He loves its oozy, squashy consistency, and learns quickly also that mud of sufficient firmness, may be shaped into most realistic biscuits and pies, which harden in the sun, so that they may be handled without losing their form. Of course, some mud serves better for this purpose, and some is not so good. He learns—empirically—to choose his mud.



Professor J. W. Sturmer

The small boy's interest is in a plastic, or moldable material—not in its chemical make-up, its constituents, or their formation. But we grown-ups may with profit devote some time and effort to a scientific study of the mud.

The automobilist who has traveled over mud roads in all kinds of weather will tell you of roads so slithery that his tires failed to obtain traction, and of baked-mud ruts almost as hard as cement, which his wheels could not crush. We all know that mud varies surprisingly in its nature and its behavior.

It is the clay soil on the farm which bakes hard, the clay in the road which forms the ruts that become so troublesome, the clay in the mud which adapts it to the needs of the young hopeful who has an imaginary order to fill for a dozen biscuits. And it is the clay constituent of earth which makes it suitable for pottery.

Now what is clay? Like mud it seems to vary endlessly in its color and its behavior. Obviously the clay which we dig up at any given spot is contaminated, is indeed a mixture of several well-known ingredients. In color it may be white, cream, buff, red, bluish, green, or of some compromise shade or tint. It may be extraordinarily plastic, or it may lack this property. Let us ask the geologist about clay.

He tells us that pure clay is white, like pure chalk and that, chemically, it is a hydrated aluminum silicate, or hydrated alumino-silicic acid, with varying ratios, however, of aluminic oxide to the acidic silicon dioxide. He tells us, next, that it is produced in nature's laboratory by the weathering of rock; that its formation has been in progress through the ages, and that it is still being formed, before our very eyes, if we will but take the trouble to look. He will explain that, in substance, "the eternal hills," built of layers of solid rock, are not as enduring as we might suppose, and that the "gnawing tooth of time," gradually but surely wears them down, the resultant rock debris forming the soil in which we grow our crops. This weathering of rock is essentially a chemical progress, although physical agencies are operative also to a considerable degree.

WHAT IS CLAY?

If the question were asked, what kind of rock is most enduring, and fit for monuments which are expected to last through the ages, the answer will probably be, *granite*—this hard conglomerate rock, which is made up of several dissimilar constituents, particles of which are plainly in evidence to the naked eye. Now, granite is composed of quartz, and mica, and feldspar, the latter a substance particularly susceptible to chemical changes by natural agencies. Chemically, feldspar is a double silicate of aluminum and of an alkali metal—with sodium, or potassium, or both of these. The effect of water, aided by carbon dioxide, on this mineral, feldspar, is to remove the salt of the alkali metal, and to leave the aluminum silicate, which, in a hydrated condition, that is, combined chemically with water, is clay. So feldspar yields clay. Other minerals of similar chemical composition also yield clay. And if the feldspar is quite pure, and the product of its decomposition is not subsequently contaminated with other rock debris, it is white. Such white deposits occur sometimes in the vicinity of the parent rock, the weathering of which produced the clay. But more frequently we find clay that has been transported by water to distant places, and in its travels has not only become contaminated with other substances, thus acquiring distinct and varied colors, but it has been also worn down to fine particles which exhibit the characteristics of colloids, characteristics by virtue of which the clay develops marked plasticity. Clay of this character, which is found in a deposit remote from its parent-rock, is called *secondary clay,* while the clay

HOW CLAY IS FORMED

which has not been transported, is purer, but not so finely subdivided, is known as *primary clay.*

Both varieties are used in pottery; the latter kind mainly because of its whiteness; and the other, because of its plasticity, for primary clay, unless it is mixed with other appropriate substances, cannot be molded. On the other hand, very plastic secondary clay may be too highly colored to be used by itself, and, what is more important, cannot be baked without undergoing distortion of form.

CLAY AND POTTERY

We know now that soil forms plastic mud on the addition of water, if it contains enough clay, and if the latter in part at least is in the colloidal state. That is to say, clay in colloidal particles—particles from .0001 to .000001 m.m.—is accountable for the plasticity and stickiness exhibited by certain soils, which makes it possible to use such soil for making molded objects like mud pies, and likewise, bricks, and other baked-earth products. On drying, such plastic clay becomes friable, but the addition of water restores the plasticity. If, however, the clay is heated sufficiently high, say to 300° C. to 500° C., the plasticity is destroyed and cannot be restored. But if soil does not contain an adequate proportion of colloidal clay, it will not cake, will not form hard ruts, and cannot be molded. Of course, most any earthy matter can be made to stick together by high heat, heat sufficiently intense to partially fuse the material. Even sand, which is silicon dioxide, and is chemically identical with quartz, can be fused. But it takes colloidal clay to make earth plastic with the addition of water.

It must be remembered that the distinction between glassware and pottery is not only in the nature of the ingredients, but also in the mode of production. Glass is an artificial rock which is plastic and moldable at a high temperature. Pottery is artificial rock produced at a temperature much below complete fusion. Glass is molded after it has been produced. Pottery is produced by firing after the molding operation, which is carried out on the raw material, this having been made plastic by admixture with water.

POTTERY AND GLASS

Since it is true than sand fuses, and most other rock substances fuse when the temperature is high enough, it follows that any kind of soil could be made into some kind of bricks, or into some kind of ware resembling pottery, provided that the shaping or molding were accomplished at an extremely high temperature. But as a matter of

fact, the development of pottery making has been altogether along the lines involving the use of earths which exhibit plasticity on the addition of water, making possible a molding or shaping process, to be followed by baking or firing.

The industry of making pottery is extremely ancient, far more ancient than the beginning of the recorded history of the human race.

THE ANCIENT ART OF POTTERY

Before the Egyptians learned to make records on papyrus, the dwellers in the valleys of the Euphrates used their clayey soil to make brick; they inscribed their historic data on tablets of clay, and rendered these permanent by a baking process. No one knows who first made the artificial building stones, which we call bricks, by baking clay. But the ruins of the temples of the Chaldeans exhibit bricks which look very much like the bricks we use at the present time; and the explorations now being carried forward in that region of Western Asia, show below the baked brick temple walls more ancient which were constructed of sun-dried brick.

How old, really, is the potter's art? When did man first observe to a purpose the sun-baked footprints made in clay soil? When did he learn to smear his rudely woven basket of twigs with clay, to dry this in the sun, to subsequently bake it over a fire, and thus to obtain a serviceable container for grain? How far back in the remote past is the stone age? And when were stone vessels first supplemented with vessels of baked clay? We know only that such vessels—even rudely ornamented with thumb-impressions, as we expect to see them on the crust of a home-baked pie—are shown in certain European museums as authentic specimens dating back to the stone age.

Certainly, of all the arts and handicrafts of today pottery-making is one of the most ancient. To be sure, it has experienced advancement in many directions.

ENTER THE ENGINEER AND THE SCIENTIST

It started as a rude handicraft, developed into an art, and more recently, experienced its principal progress because of the advent of the engineer, whose triumphs have been along the lines of scientific factory production, with automatic machines performing most of the work formerly done by hand. Furthermore, science is replacing, very largely at least, the rule-of-thumb procedure of the past in the choosing of the raw material, and in the control of the details of manufacture. Thus, for example, our ancient pottery, like our bricks, were made of mud just as it happened to occur in nature. If perchance such pottery was superior, either

in appearance, strength or in imperviousness to liquids, it was due to the fact that the mud, as a happy accident, contained, naturally, the ingredients which make good pottery. In other words, the clay used contained the right sort of impurities. This accounts, for example, for the excellent qualities of certain early Chinese ware.

The modern potter, however, does not depend upon luck to provide him with his raw material, mixed in the right proportions in nature's workshop. He uses, it is true, certain secondary clays, like the "ball clays," which are far from being pure hydrated aluminum silicate; and because of this, a degree of uncertainty still exists until actual factory trials have been carried out. But speaking generally, he has learned to compound his earths so as to achieve the desired results. Of course, common bricks, and crude pottery, are still made of clay soil as it occurs in the field. And at this point we may profitably note certain facts about bricks, and their manufacture, which will help us to understand the fundamentals of pottery in general.

BRICKS AND THE FUNDAMENTALS OF POTTERY MANUFACTURE

We note for example that some bricks are extremely porous and can absorb a large quantity of water? Why are they porous?

There are also non-porous bricks which are very much harder and sometimes a bit distorted and of a darker color. What causes the difference?

Suppose we visit an old-fashioned brickyard, where the engineer and the efficiency expert have not as yet installed complicated mechanical devices to divert our attention. We find here that the clay soil is worked to a homogeneous putty-like consistency in a machine operated by horsepower, the poor beast being compelled to follow his nose around a circle, slowly but continuously, for a long time, thus revolving the machinery which works a kind of huge dough mixer. Then the pasty mud is forced out of an orifice and molded. Next the cakes which are the bricks-to-be, are dried. Finally they are stacked in a kiln, and the firing does the rest. After the fire has died down, and the bricks have cooled, these are taken out, and sorted. Those which were remotest from the fire are a little larger than the other bricks, are paler in color, are quite friable, and very porous and absorbent. The bricks which were in direct contact with the fire and the fuel gases, are smaller, sometimes distorted, and may exhibit a brown, black, bluish, or greenish color. These bricks are very hard, non-absorbent, and are characterized as vitrified—an adjective derived from the Latin word, vitrum, meaning glass. The bricks which

occupied an intermediate position with reference to the fire and the fuel gases, are also intermediate in point of hardness, porosity, size, and in depth of color. These are the bricks for ordinary house-building, while the paler and more friable bricks are usable for inside walls, and the very hard, vitreous bricks are reserved for specific uses where their distinctive properties prove of value.

Now let us look for the reasons for these variations; reasons which we can find by studying the action of fire on these sun-dried cakes of mud.

POROUS AND VITRIFIED BRICKS

In the first place we must remember that these dried mud cakes still contain moisture or water, which gradually escapes as the temperature rises, and in so doing, develops porosity, to which is due the permeability to water of soft-burnt brick. We must remember also that clay itself is a *hydrated* aluminum silicate, or better, a *hydrated* alumino-silicic acid, which, at a given temperature gives up the elements of water, with the production of the latter compound; and that the escape of this further enhances porosity. Of course, this pre-supposes that the temperature at which enough molten material is produced to fill the interstices or pores, has not been reached when the heating is discontinued. If, on the other hand, the temperature is raised sufficiently, and the heating continued long enough, the glass-like bonding material entirely fills the pores, and the resulting brick is vitreous, hard and non-absorptive. Whether such a brick will be distorted in shape will depend largely upon the composition of the raw soil employed in the process, a subject which will be again referred to in connection with pottery.

Now as regards the color: The earth or soil employed in brick-making is invariably colored; but we cannot foretell the color of the finished brick from the color of the raw earth, unless we know its compostion, and know something, also, about the color changes effected by the firing process.

COLOR OF BRICKS

Thus, the earth may be black with organic matter and elementary carbon, a color which disappears in the heating for obvious reasons. Or the clay may be buff colored with hydrated oxide of iron, which burns to a bright "brick red." A clay soil fairly rich in iron may, on the other hand, produce a white, or cream-colored brick, due to the presence of certain constituents like calcium carbonate, forming calcium oxide, which interfere with the development of the red color. Nor is the relative iron-content indicative of the depth of color which may be expected,

for so much depends upon the degree of subdivision of this iron compound. Furthermore, the reducing effect of the flue gases, when there in an inadequate supply of air, must be considered, for at a temperature sufficiently high, black oxide of iron, and also ferrous silicate, which is greenish, may be formed, and the brick may turn bluish, greenish, or black, because of chemical alteration of the ferric oxide. Such effects are sometimes produced intentionally, as is also the mottled or variegated appearance in brick, which is the result of alternately providing a reducing and an oxidizing atmosphere in the kiln.

The red color of brick develops progressively as the temperature rises in the kiln, until the maximum is reached, at about 1100° C. When the temperature exceeds this, the bricks turn brown, and eventually black or bluish black, because of the formation of much vitreous matter, and the reduction of the ferric oxide, with the development of iron silicates—results which, however, depend not solely upon the temperature, for the composition of the kiln gases must also be taken into account.

The dark brown or black bricks, so largely used in Flemish masonry, and very common in the old buildings of Philadelphia, are colored with iron and manganese; and sometimes the dark bricks are produced by manipulating the fires in such a manner that vitrification occurs before all the carbon has been burned out of the clay, and this carbon becoming fixed, serving as a pigment.

Fire brick is usually cream or buff in color—seldom red; for red-burning clays are usually not sufficiently refractory. But fire brick sometimes exhibit a brindled effect, due to black spots, which are the result of the decomposition of iron pyrites particles present in some fire clays.

Brick making is a most important branch of the ceramic industry, and is no longer carried on in the primitive and empiric manner previously referred to. But the limitations of time (and space) preclude a description of the modern processes which are indeed triumphs of engineering skill and illustrate the value of the application of science to industry. The important fact—to us—is that these artificial building stones, common bricks, are burnt or baked clay, clay with such admixtures as are provided in nature. Tiles and terra cotta are likewise burnt clay—only formed in a different mold. To be sure, the clay must be carefully chosen, particularly from the standpoint of texture. But the same applies to bricks, when a specific type of brick is desired.

As has been stated, the melting point of pure clay is high, about 1750° C., which is comparable to the melting point of platinum.

IMPURITIES MAY BE DESIRABLE

Hence there would be great difficulty in making bricks or tiles, or any ceramic ware, for that matter, out of pure clay alone. But the impurities naturally found in clays appreciably affect the melting point. Indeed, it is to the impurities that we must look in brick clay for the production of the vitreous matter which serves as a bonding material, to bind together the unfused clay particles. Hence it appears that every deposit of brick clay has its own characteristics, not only from the standpoint of the color developed, but also in the extent of vitrefication resulting at a given temperature. And the same holds true in the manufacture of crude pottery.

Another point to remember is that highly plastic clays, containing a relatively large amount of clay in the colloidal state, are prone to shrink and crack considerably on drying, and that objects made of such clays, on firing, experience distortion.

Bearing these facts in mind, we can see how true it is that primitive pottery-making was a handicraft in which the elements of chance or luck figured largely, and that it was accidental when a deposit was found which gave good results.

A HANDICRAFT

The pottery of the American Indian, for example, falls in this category of ware made from a clay soil rather than from a mixture of materials. It is similar in character to our common flower pots, which is true also for the very ancient specimens of urns and vases found in Western Asia.

Flower pots are buff, or a shade of red, according to the iron content of the clay employed. They are fired at a comparatively low temperature. Hence the vitreous bonding material produced is small in quantity, and does not fill the pores developed in the drying and in the earlier stages of the firing, due to the escape of the water. We may compare the internal structure of such ware to that of a popcorn ball in which the grains are stuck together by melted sugar. A flower pot, or similar ware, will, naturally, be pervious to water, and we may expect it to be rather friable, which indeed it is, just like a soft-burned brick.

But a higher temperature will, if the clay contains the right impurities, produce enough vitreous matter to make the ware impervious, a fact which was undoubtedly known quite early in the devel-

opment of pottery. This higher temperature, however, also tended to distort the ware.

Now, in decorating pottery, using earthy deposits for pigments, it was found that some tended to form an impervious and non-porous glaze. So in time the expedient of covering the entire article with a glaze was thought of, and carried into execution. Thus developed glazed ware, which is now so extensively used.

But long before glaze had been discovered, the art of manipulating the plastic clay into shapely forms had made progress, and even the stone age specimens are not devoid of beauty of outline. In the early Egyptian era the potter's wheel came into use, a device which is employed to this day, making possible the symmetrical shapes of urns and vases.

SCIENTIFIC COMPOUNDING

If we except bricks, tiles, coarse pottery, like flower pots and similar ware, we may say that modern pottery is not made from clay soil, but from a material which is compounded, and in which ingredients of fairly definite chemical composition, and of known physical and chemical properties, play a part.

Modern pottery may be classified under the three captions, earthenware, stoneware, and porcelain.

Earthenware is absorbent, like a soft-burned brick, but may be of a much finer texture, and be nearly devoid of color. Our cheaper dinner plates, cups and saucers, are glazed earthenware, a very serviceable kind of pottery which was originated in England in the 18th century, by Josiah Wedgewood, the most famous potter of his day. Table ware of this character is, of course, always glazed, and is commonly known as queen's ware.

Stoneware is quite different from earthenware in that it is non-absorbent, impervious to liquids, and is very hard—hence the name. It is largely employed in chemical manufacturing because of its durability, and because of its being resistive to the action of acids and of many other chemical agents.

Porcelain differs from stoneware in that its fracture is glassy rather than stoney, and also in that it is translucent, while stoneware is opaque. China is really porcelain, and not a different type of ware, although in popular usage the word is sometimes used as a synonym for queen's ware, which is not correct, for the name China ware is derived from the fact that the first specimens of white, translucent pottery which reached Europe, had come from China.

Bone china is a particular type of porcelain in the production of which bone ash is used as one of the ingredients.

THE RAW MATERIALS OF THE MODERN POTTER

The principal raw materials for the modern potter are kaolin, ball clay, feldspar, and quartz or flint. From these may be made earthenware, stoneware, or porcelain, depending upon the type of clays used, the proportions, and the control of the temperature in the firing.

Kaolin is a white, lean clay, the term "lean" signifying that it is devoid, or nearly devoid, of plasticity. It is almost pure hydrated alumino-silicic acid, corresponding to the formula $Al_2O_3.2SiO_2.2H_2O$, and it has a high melting point, namely about 1750° C.

Ball clays are plastic clays, containing much colloidal material. They are contaminated with various impurities, and may be rather highly colored. They do not usually burn white, which is a drawback, and explains the use of kaolin to replace the ball clay as far as possible. Indeed, only enough of the latter is used to impart sufficient plasticity to the mixture so that it may be shaped or molded.

The feldspar is employed because of its fusibility, and it furnishes the vitreous material in which a portion of the clay and the quartz dissolve, thus forming a matrix for the unfused and undissolved particles.

Silicon dioxide in the form of quartz or flint constitutes one-fourth to one-third, by weight, of the mixture of raw materials employed in modern pottery. It is indispensable. Its purpose is to reduce shrinkage in drying, and distortion in firing. There is, however, little or no unchanged quartz in porcelain, or in any other ceramic product which has been subjected to high heat, for quartz, at high temperatures, undergoes definite modifications, and moreover, a portion of it combines with the fused feldspar to produce a glass, thus further enriching the matrix.

THE PROCEDURE

The first step in the process of pottery making is the production of an intimate mixture of the ingredients, which, with the exception of ball clay, are obtained in the form of a fine powder. Such a mixture is effected, not in the dry state, but by making a water-suspension of each ingredient, and then mixing the several liquids, called slips, an operation which is usually done in a ball mill. Next, the magma is passed through sieves, and then over electro-magnets to remove iron particles, should any be present. Following this the magma or slip is passed through a filter press, to remove the excess of water.

The cakes of clay-like material from the filter press are next worked to homogeneity in a mixing machine, from which the soft paste is forced in form of a cylinder. This may be cut into convenient lengths for the shaping operation, prior to which, however, the paste is sometimes "aged" to enhance the plasticity.

We have now a moldable mud, comparable to the mud from which bricks are made, but unlike the latter, of rather definite composition, the kaolin, ball clay, feldspar, and the quartz, in the proportions which experience, and many trials, have shown to work best for the type of ware which is to be produced.

There now remain the shaping, drying, and the firing.

For the shaping operation the use of plaster of paris molds is now largely resorted to with marked success. That is to say, many pieces of pottery are now made by *casting*. And for this operation the mud must be thin enough to pour, yet rich enough in solids to speedily form a layer or shell of deposit on the inside walls of the mold. To make such a suspension, sodium silicate, or sodium carbonate may be employed as a deflocculating agent. A small amount of either of these substances tends to make the clay paste quite fluid, despite the fact that it contains practically as much solid matter as a paste of the right consistency for molding with the hands.*

CASTING AND MOLDING

When the deposit on the inside walls of the plaster mold is adequately thick, the excess of the suspension is poured out, and when the shell of deposit has sufficiently hardened, because of the absorption of water from it by the plaster mold, the latter is opened, and the shell, which in this operation has experienced some shrinkage, can easily be removed. It is now carefully tooled, scraped and polished, to remove all blemishes, after which it is ready for the drying shelf, in the so-called "green room."

Some articles, like cups, are cast in this manner, but while in the opened mold, are given their proper inside contour by means of a tool which is held in position while the cup whirls on a turn table, on which it has been carefully centered. This operation is called "jiggering," and may be used also when the clay is not cast, but is, in a plastic condition, pressed into the mold. The shaping tool is at-

*This deflocculation is the opposite of the phenomenon occurring at the mouth of the Mississippi, where the fresh water, bearing great quantities of colloidal clay, merges in the salt water, at which point the salts flocculate the suspended solid matter, causing it to settle, and to gradually build up solid earth, a process which explains the delta formation at the mouth of this great stream.

tached to a lever which may be raised or lowered as needed, from a support above the turn table. The whole apparatus is known as a "pull down." Many articles are neither molded, nor cast, but are shaped by hand, and with the aid of simple tools. Vases, urns, and jars, may be shaped on the potter's wheel, an operation which requires great skill, but which cannot be satisfactorily described.

When the ware has dried sufficiently, it is ready for the firing. The kilns used are conical in shape, are 16 to 18 feet in diameter, and terminate in a large smoke stack. The fuel now employed is either coal, or fuel oil.

THE FIRING

Before the fire is kindled, the ware is stacked in the kiln, to a considerable height. To make this stacking possible, and, what is more important, to protect the ware from direct contact with the flames, the individual articles are first put into containers made of baked fire clay. These containers are called "saggers," and stacked columns of them in the kiln are called "bungs."

When the kiln has been filled with ware, the opening is bricked up, and the charge is ready for the firing.

Firing pottery is an art—not a science, although recourse is had to scientific methods of temperature measurement and fire control. A pyrometer—a thermometer for high temperatures—is, of course, used. In addition, the operator in charge of the firing, puts into the kiln small cones of ceramic material of such composition as to soften and bend at certain definite temperatures. The cones, which are called Seger cones, in honor of the inventor, are fastened, upon a base in groups of three, the middle one softening at the temperature at which the ware is to be fired; the one in front of it, at a temperature a little below this, so as to give warning that the desired temperature has been approached; and the third, with a higher softening point, to show that this temperature has not been appreciably exceeded. In addition, rings of ceramic material may be used in the kiln, rings which indicate by their shrinkage, ascertainable by accurate measuring instruments, how far the firing process has progressed.

The temperature must rise just in the right manner and speed, must not exceed a certain height, must be maintained at that height just long enough, and the kiln must then be cooled at just the correct speed. The performing of such an operation is indeed an art. Yet to fail in it, means the ruination of the ware.

When the kiln has cooled, the fire bricks which closed the opening are taken out, and the ware is brought forth and removed from

the saggers. It is now known as "bisque" or "bisquet" which is really a misnomer, for the word signified "twice burned," whereas the ware has so far undergone but a single firing. Whether it is porous and friable, or vitreous and hard, depends upon the composition, and upon the temperature employed. Crude earthenware is fired to about 750° C. to 1150° C., stoneware to about 1250° C., porcelain as high as 1500° C. The entire firing process takes from 24 hours to about two and a half days.

During ths heating, a number of chemical changes take place. Hydrogen and oxygen in the proportion in which these exist in the water molecule are liberated, and escape in the form of steam. The quartz changes largely to cristobalite, which is one of the isomeric forms of silicon dioxide.

CHEMICAL CHANGES

The kaolin, and the other clays, are converted into mullite, $3Al_2O_3.2SiO_2$. And the feldspar forms a molten glass which dissolves not only some of the clay, but also some quartz with which it forms a type of "acid glass," glass with an excess of SiO_2, comparable in this respect to the well known pyrex. The extent to which this glass-formation progresses, and the nature of the unfused and undissolved particles, determine the translucency of such ware as porcelain.

GLAZING

Our porcelain table ware is always glazed. So are many other modern ceramic wares. A glaze, as the word indicates, is a kind of glass. and there are many kinds. The glaze may be translucent, or it may be quite opaque. It may be colorless, white, or colored.

Stoneware is frequently salt-glazed, which is accomplished by throwing salt upon the fire so that it may be volatilized, and brought in contact with the ware. The salt reacts with the silicates at the high temperature, with the liberation of hydrochloric acid, and the production of a fusible sodium and aluminum silicate, which constitutes a very durable and highly satisfactory glaze, not, however, a particularly beautiful one.

A glaze which melts at a relatively low temperature is made with a lead base, and is in reality a kind of lead glass. Sometimes it is a boro-silicate, boric acid being used in its production. The "little brown jug" of song and story was lead glazed, as is much of our common coarse pottery.

Porcelain is glazed with a feldspathic glaze, consisting of pretty nearly the same constituents used in making the body of the ware,

but more fusible than the latter, because of its containing also some lime. A common high-fire feldspathic glaze is made of feldspar, quartz, kaolin, and whiting.

The material for glazing is converted into a magma or slip into which the ware may be dipped—or the slip may be poured on, or brushed on.

The composition of the glaze must be carefully adjusted to the porcelain which it is to cover, particularly from the standpoint of thermal expansion, lest the glaze develop innumerable cracks, a phenomenon known as crazing. The hardness, and the tensile strength, and other physical properties, also have a bearing in precluding "crazing." In certain ornamental ware, as in a type of Chinese vases, crazing is intentional. But in case of table ware, particularly earthenware, the tendency to craze is a very grave imperfection.

While most glazes are glossy and translucent, there are also opaque glazes, this effect being produced usually by the addition of tin oxide to the formula.

Glazes, like glass, may be colored—blue with cobalt, brown with manganese, green with chromium, etc. The royal blue, so much admired in tableware, is cobalt rendered deeper and darker blue by the addition of zinc, or of boric acid, while a light blue may be obtained by using the cobalt in conjunction with alumina. Some pigments can withstand strong heating, while others are destroyed by high temperature, and must be used in connection with low-melting glazes. This is particularly true of the pinks and purples.

UNDER AND OVER

The decorations may be put on the bisque, and the glaze put over it, a procedure illustrated by much of our tableware. This method is known as "under-glazing." Over-glaze ware, on the other hand, is first glazed, then decorated, the decoration being burnt into the glaze by a low-temperature firing process. So it appears that the colors may be below the glaze, in it, or upon it. "China painting," as it is customarily carried out, involves the over-glaze procedure. While "hand-painted" ware is made industrially to some extent, the process known as decalcomania is more commonly resorted to in the "decoration" of tableware. The procedure is quite simple. The artist's original is reproduced by a printing process, on a soft paper. This is pasted—face down—upon the ware which has been coated with a thin varnish; the paper is soaked off in water, and thus the picture is "transferred," and may be imbedded in the glaze by firing.

Decalcomania may be employed also in connection with the underglaze process, in which case, however, the higher temperature employed in the glazing limits the choice of colors.

Our museums exhibit treasures of the ceramic art, from very ancient periods to the present time. It is interesting to note the improvements in perfection of outline, texture, ornamentation, and other details; to note when vitrified clay products first appeared, when glazes came into use, and when certain types of ornamentations had their initial vogue. Just as we have period furniture, so have we also period ceramic ware; and antiques in pottery are as much sought after as are the antiques in cabinet work. But the study of such matters is really historical, and is foreign to the scope of this lecture.

It is, indeed, a far cry from mud cakes to porcelain, or from the coarse pottery of ancient times to the beautiful objects of art which may now be purchased at a comparatively low price, thanks to the physicist, the chemist, and the engineer, who have transformed an ancient handicraft into a modern industry, organized for factory production. But essentially the story of ceramics is still the Story of Burnt Clay.

HORMONES—VITAL SUBSTANCES IN LIFE

By Dr. Arno Viehoever

"Man may mold stature and character as the sculptor molds his clay."

OUR STORY, strange as it may seem, has a close connection with the tales of giants and dwarfs, with the fate of the criminal, the insane, the perverted, the fat or skinny, the dull and bright, courageous and shy, well and sick, young and old—yes, very, very old. The tales of the unusual in man and lower animals, of the "Mutts and Jeffs," have fascinated us—the sight of monstrosities in the circus have often shocked, always attracted us.

Arno Viehoever

The story of Alice in Wonderland has charmed us—and delights equally our children. You remember Alice standing in the rabbit hole, before a small passage leading to a beautiful garden. A good sip, in fact the finish, of a little bottle labeled "Drink me" caused her to shrink instantly. Only ten inches high, Alice could go through the little door to the garden but found it locked. The golden key was on the table and well out of her reach. Wondering, worrying what she could do to grow big again she spied under the table a little glass box containing a piece of cake marked "Eat me." She ate it all and, alas, her body stretched until her head struck the roof of the hall and Alice was as tall as a beanpole—rather more than nine feet high.

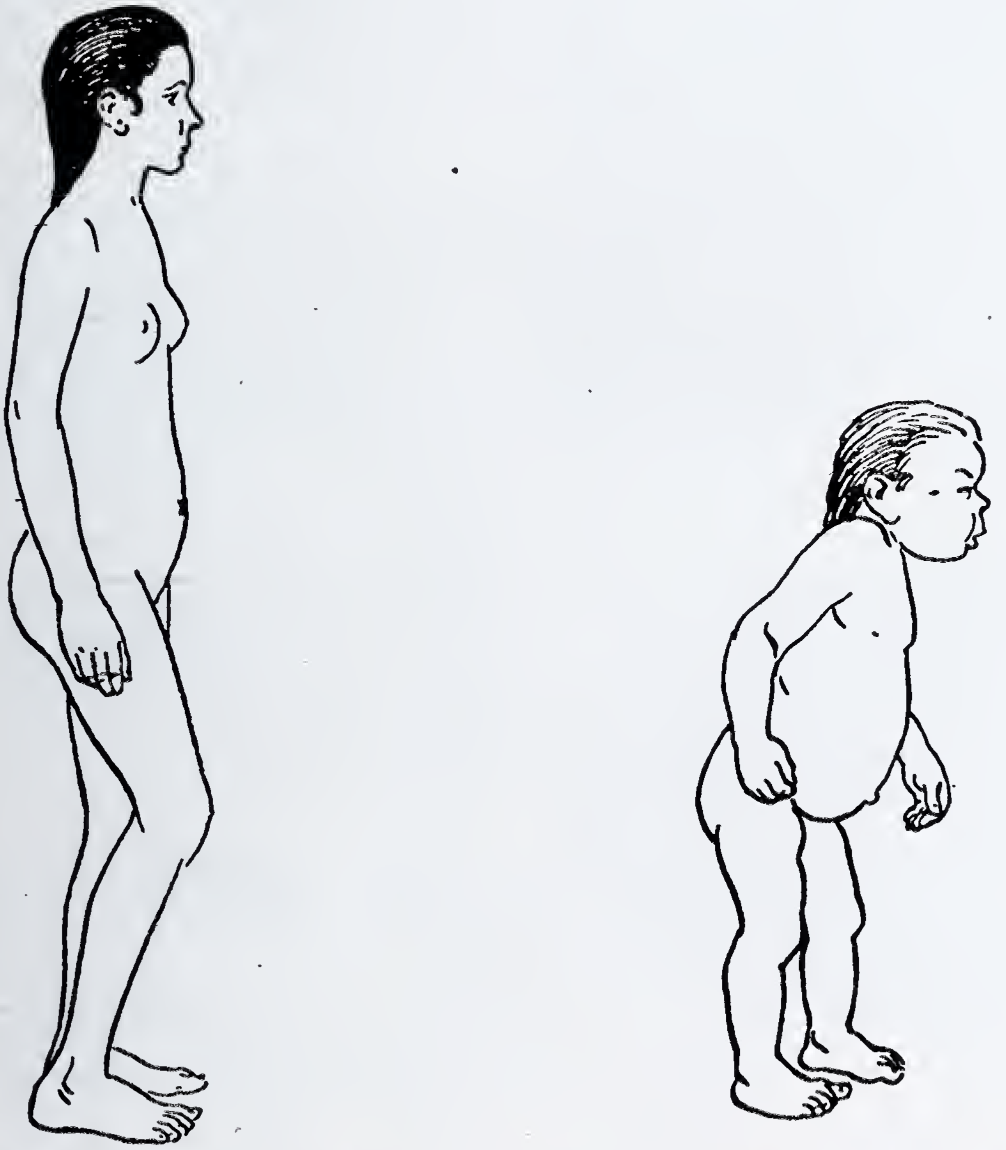
The play of a writer's phantasy—yes, and yet: the study of hormones reveals them as "Marvelous powers behind the throne of the living tissue" (Paton). The knowledge of hormones seemingly places within man's hand the control of nutrition, the mastery of organs and their functions. Even the dubious must be convinced of the wonders possible with hormone treatment, if they are confronted with evidence, such as may daily now be observed. Does not the case of a fifteen-year-old crippled, monkey-like girl, transformed in six years of care into an attractive flapper, equal the story of Alice? (See Fig. 1.)

I

Animal Hormones—Agents of Animal Life

The history of animal hormones is mainly the story of glands—and gland extracts.

As often in the history of medicine and pharmacy, Paracelsus, active 400 years ago, must be mentioned among the pioneers. A



1. Alice transformed through prolonged thyroid treatment. After Koelsch.

keen observer, a believer in the chemical nature of organic function, he concluded that material essential for well-being of the individual is distilled from one organ into another.

He or his pupils even tried to distill the mystic soul substance as the volatile spirit from the brain. The development in the knowledge of glands was very slow. Even fifty years ago when the functions of the brain were already well known—the various body glands meant little more than names. Not much was known of their structure, nothing of their functions.

Real and steady progress dates from 1889. Brown Séguard, of Petrograd, then seventy-two years old, presented before the Biological Society of Paris his results of injecting under his own skin an extract of testicles (liquide testiculaire), claiming surprising invigorating effects on his physical and mental ability. He suggested that beneficial effects are also obtained from other organic extracts. "Les manifestations morbides qui dépendent chez l'home de la sécretion interne d'un des organes doivent être combattues par des injections d'extraits liquides retirés de cet organe pris chez un animal en bonne santé." He focused attention again on the use of age-old remedies from the animal kingdom.

Just two years later Poehl announced the preparation of "Spermin" as the ferment of the male glands—normally circulating in blood, acting against assumed auto-intoxication, the cause of many infectious diseases through interorganic oxydation. He stimulated interest in organo therapy claiming that certain secretions of normal animal glands remove abnormal conditions in the workings of the human machine. Using first the fresh, then the dried extracts of these glands, he endeavored to prepare products and to isolate the active substances. We have a record of the use (1896) of organ preparations from four different glands (and even the brain). Having been prepared according to different methods, their activity was quite varied.

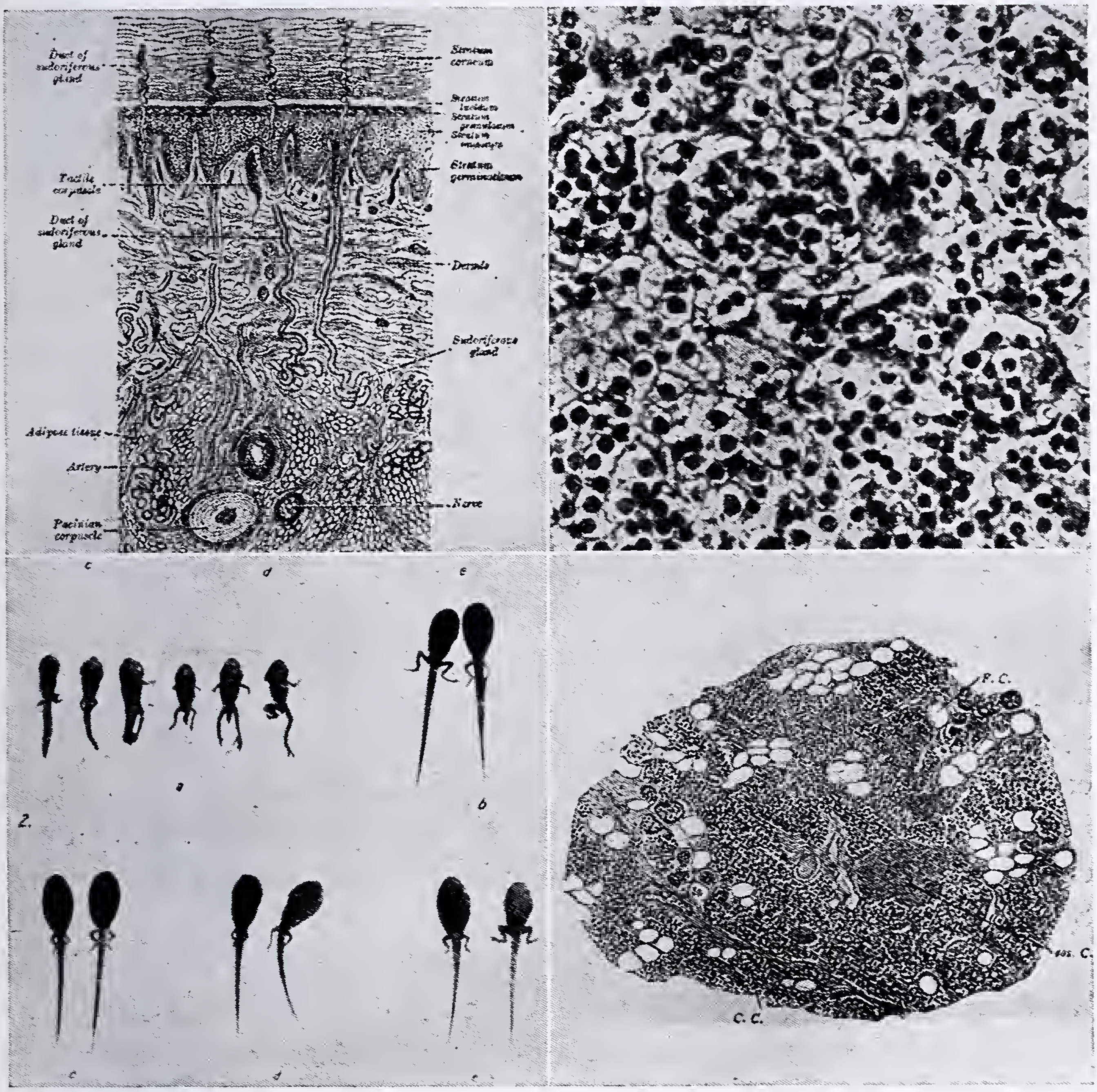
Nevertheless, remarkable results were obtained and seemed to justify the age-old instinctive teaching of Hippocrates and others as well as Hahnemann's motto "Similia Similibus": Like cures like.

As mentioned, man, aroused by the striking results obtained with some gland extracts, extended his study of all body glands. As a result he learned to differentiate between them and to define their functions.

EXTERNAL GLANDS

The saliva in the mouth is produced from blood substance, in glandular tissue (saliva gland) located in front of the ears, between the lower jaw and floor of the mouth. Tubes, called ducts, bring the secretion from its manufacturing gland to the mouth. There the enzyme ptyalin in the secreted saliva converts the starch of foods into chemically simpler substances—such as sugar. Other examples of external secretive glands are those lining the stomach wall, forming pepsin and rennin, those producing the pancreatic juices containing the enzymes trypsin, steapsin (fat splitting enzyme), amylopsin (dia-

stase), the intestinal juices with diastase, those producing bile from the liver and sweat glands excreting poisons and waste products. See Fig. 2a.



2. Upper left: Sweatglands of the skin, with coiled ducts. After Gray.
Upper right: Human parathyroid; glandular tissue 400 times magnified. After Sharpey Schaefer.
Lower left: a. Tadpoles fed on thyroid, dwarfed but transformed; b. Tadpoles fed on thymus; c. Tadpoles fed on liver; d. Tadpoles fed on muscle; e. Tadpoles fed on adrenal. After Gudernatch.
Lower right: Parathyroid, typical ductless or endocrine gland; fat cells, resting and active cells. After Falta.

INTERNAL GLANDS

As a rule these have no tube or duct outlet, but pass their secretion directly into the blood and were therefore called ductless; they are now generally called endocrine. See Fig. 2d. This secretion contains a group of substances, first called hormones in 1907—or chemical messengers, inasmuch as they either excite or restrain the activity of another

organ. Eight different glands are considered now as part of the endocrine system. From some active principles have been isolated, from some active products have been prepared. The presence of hormones in others is still undecided.

The hormones act without any help from the brain. Almost infinitesimally small amounts of hormone are needed to cure deficiencies. They are generally found in very small amounts in the tissues—Kendall had to use over 6500 pounds of fresh thyroid to obtain one ounce of the hormone thyroxin.

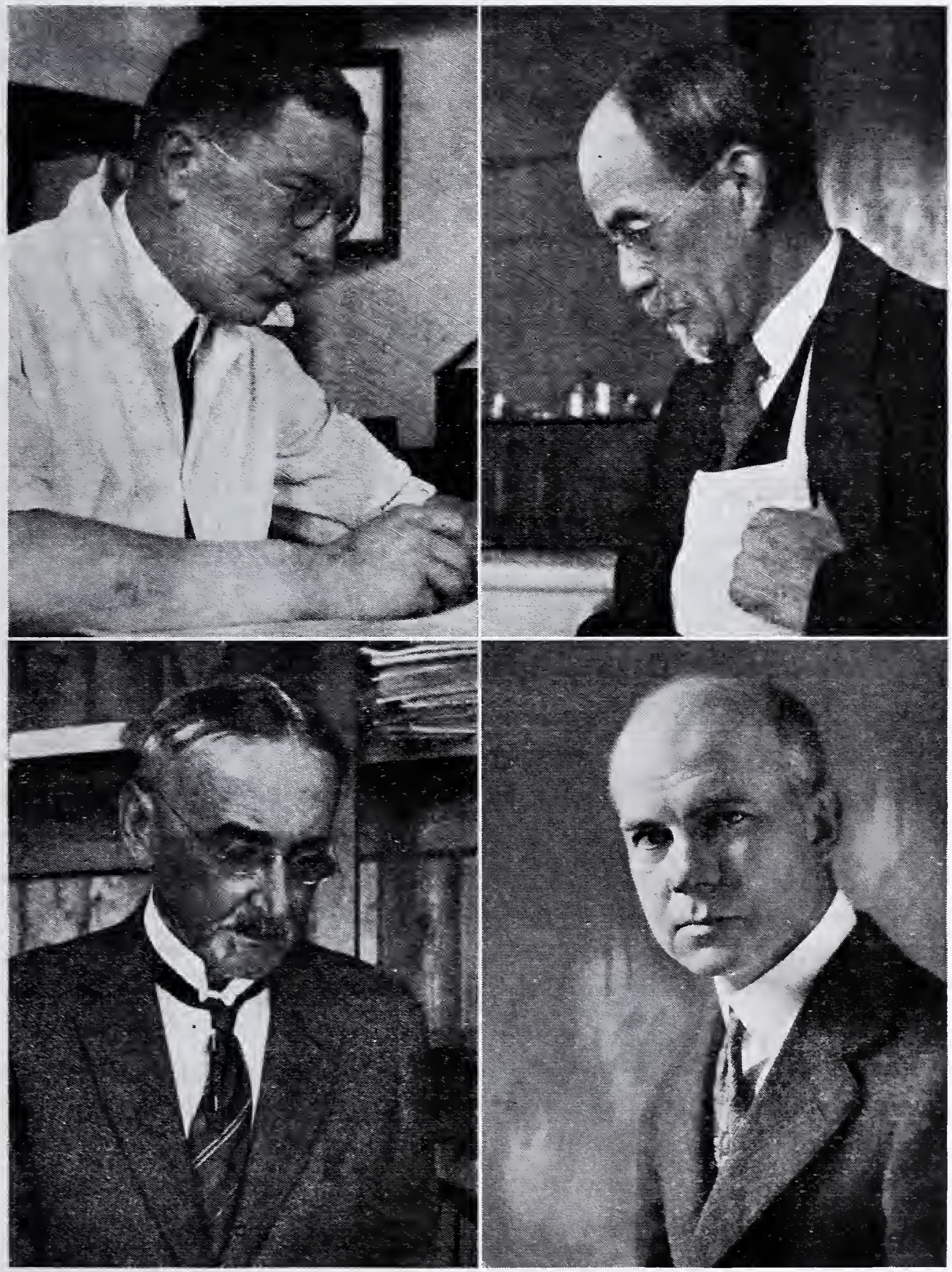
VITAL AGENTS AND THEIR SCOPE OF ACTION

Hormones have been compared with vitamines, and more recently with amino acids, building stones of food proteins obtained through enzymatic or acid digestion. Working like enzymes and vitamines in bringing about chemical changes in a large quantity of material, without seemingly undergoing any permanent change—these hormones may therefore too be classified as catalysts. Taking part in the activities of the living organism, we may call them biological catalysts.

One pioneer worker who for at least thirty years has given his best efforts to this study, is an American, Dr. J. J. Abel, connected since 1893 with Johns Hopkins University. Of four purified gland extracts available now, he is responsible for the isolation of three, including crystaline insulin. He thus placed the entire study on a definite and quantitative basis—so necessary in the biological field. See Fig. 3b.

With the isolation and close study of the function of these pure hormones, the recognition increases that some of these substances, as for instance insulin, are not strictly chemical messengers, acting as stimulants of an organ situated at a distance. They are catalysts, performing a specific chemical function, whether secreted by the gland or introduced into the blood—whether extracted from animal or vegetable source or synthesized in the laboratory.

Much credit for our increased knowledge of the function of glands is due Dr. Fred S. Hammett, a research worker in the Wistar Institute of Anatomy and Biology, Philadelphia, who has thus far published over thirty-eight papers on the thyroid gland alone. Dr. Sajous, Professor of Endocrinology at the University of Pennsylvania—and practicing physician, summarizes the indication of his research, covering a period of thirty years: "The endocrine organs are the missing factors in our lack of knowledge concerning the



3. Upper left: Dr. F. G. Banting, Toronto University, Canada.
Lower left: Dr. Jacques Loeb(†). Late of Rockefeller Institute, New York.
Upper right: Dr. J. J. Abel, Johns Hopkins University, Baltimore.
Lower right: Dr. E. C. Kendall, Mayo Clinic, Rochester, Minn.

relation between cause and effect, in many directions, their secretions supply all tissues with functional constituents which in health sustain the vital process—and in disease defend it.

"Various biochemical bodies, long known to exist in all tissues but those functions therein had remained obscure, are shown to explain the relations between cause and effect referred to, *e. g.*, how pathogenic agents cause disease, the manner in which they produce organic changes in the tissues and evoke symptoms, and how various remedial measures produce curative and prophylactic effects. On the basis of clinical experience utilizing these newer principles, marked progress is shown to be possible in the prevention and treatment of insanity and feeblemindedness, various pulmonary diseases, including pneumonia, bone diseases, including rickets, cardiovascular diseases, (pertaining to the heart and blood vessels), and including arteriosclerosis, and various other disorders now causing untimely death or much suffering. The endocrine organs—a foundation for scientific medicine."

E. Slosson, speaking of character chemistry and chemistry's effect on character, recently said, "The chemist of the future will turn from his humble task of providing the convenience of life and gain control of life itself. He may mold stature and character as the sculptor molds his clay.

What we value as individuality, fascinating temperament, charms of vivacity, woe and sympathy—are all due to definite hormones, some of which are already known as chemical compounds. Courage is not a matter of sand, but of sugar.

Diabetic patients who are gripped with a form of fear from an overdose of insulin, may have their courage immediately restored by sucking a lollypop.

A variation of a few hundredths of 1 per cent. in the glucose of the blood may make the difference between cowardice and courage, may determine whether a man shall be shot as a slacker or medalled as a hero."

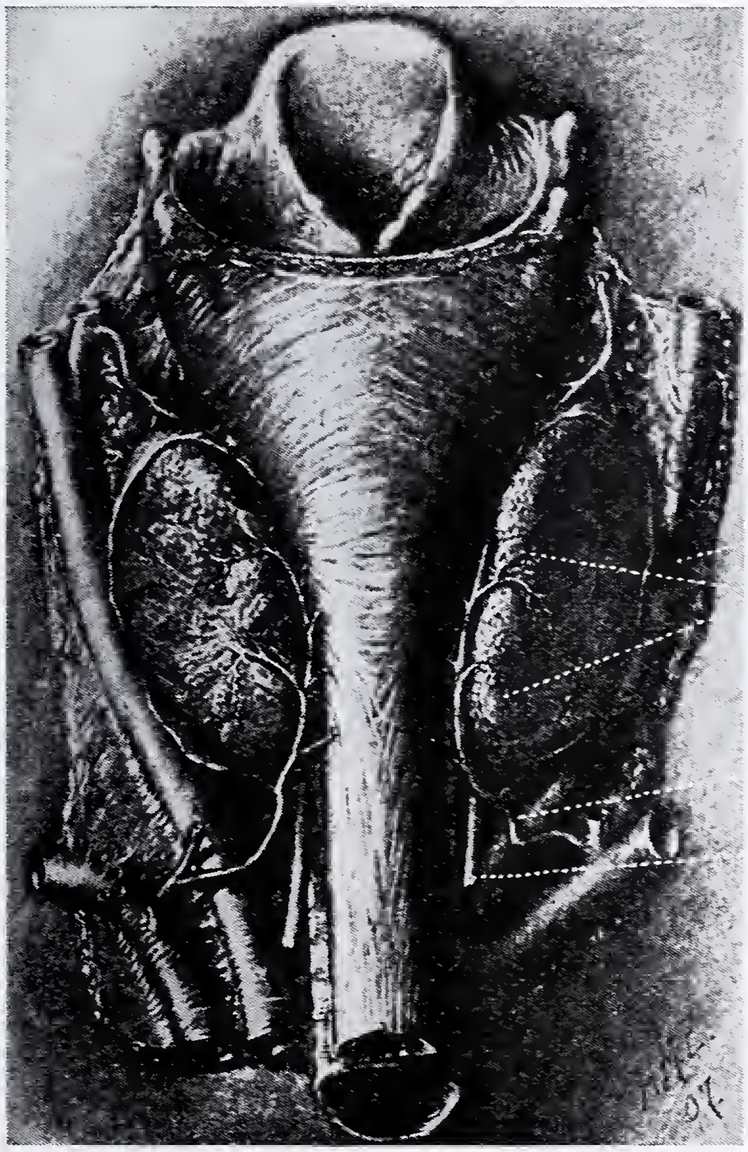
Popular writers, inspired by reports of unusual results, have attributed to the glands and their hormones still more wonderful—sometimes unproved—faculties:

Abraham Lincoln, according to Williams, exemplifies action of active pituitary tuned in exact harmony with other glands of internal secretion—tall, individual, sparse and muscular, intelligent with high ideals, tireless and with persistency of purpose—the pituitary type

at best. Joe, a flat chested, flabby muscled, overgrown boy, with sexual infantilism—as described by Dickens, in "Pickwick Papers," represents a type familiar to every clinician.

We will do well to consider the scientific method, now followed in the study of endocrine glands and hormones and further discussed by Raabe.

1. Clinical observations of sickness of endocrine organs.
2. Operative removal of endocrine glands and observation of results.



4. Thyroid and Parathyroid Glands in Human Throat; the two small parathyroid glands are imbedded in either thyroid lobe. After Halsted and Evans.

3. Replacement of removed glands through implantation of own or foreign organs and observations of possible restitution of certain disturbances.
4. Introduction of parts of effective extracts of endocrine organs or the isolated active principle into

1) individual with normal endocrine glands;
2) individual with defective endocrine glands.

5. Voluntary influence of nerve system of
   1) healthy individuals;
   2) sick individuals.

through exclusion or stimulation of certain parts of central nerve system or periphery, and observation of a possible modification of certain known reactions from the sphere of action of hormones.

6. Voluntary influence exerted upon the ion sphere of such an individual through the introduction of or the induced secretion of certain substances, and observation as in point 5.
7. Analytical and quantitative detection of active principle of certain hormones in organs, blood, etc., under certain circumstances.
8. Examination of effect of active hormone preparations upon isolated organs or tissue parts, and tissue blood serum, etc., of
   1) individuals with normal glands;
   2) individuals with defective glands.

Specific Hormones

1. THYROXIN: THE HORMONE OF THE THYROID ("HEALTH OR VANITY GLAND")

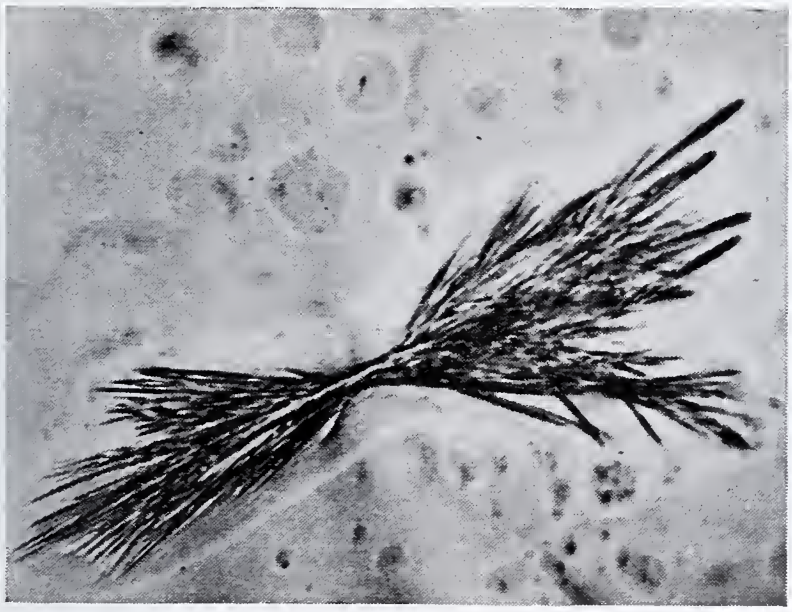
The thyroid gland, consisting of two lateral lobes, is located in the throat, on either side of the trachea and larynx, and weighs about one ounce in the adult person. See Fig. 4. The organ is composed of follicles, the epithelium cells lining the walls of globular pockets or alveoli, containing a peculiar colloidal material.

Baumann's discovery (1895) of iodin, as a normal constituent in the thyroid gland, led to the extension of the iodin treatment against goitre and scrophulous diseases, and many attempts to isolate the active compound.

Baumann ashed the desiccated gland substance in an alkaline potassium nitrate medium—and extracted the acidified residue with chloroform which dissolves iodine with violet color. The comparison of this color with that of iodine solution of known strength permitted even quantitative experiments. Baumann called his non-protein nitrogenous substance iodothyrin. Oswald (1899) isolated iodinic protein—iodothyro globulin, with a physiological activity comparable to that of the entire gland and evidently proportional to its iodine content.

All attempts to obtain a pure crystaline substance failed until Kendall (1917) (see Fig. 3d) of the Mayo Foundation, changed the general analytical procedure using alkaline instead of acid hydrolysis. He thus obtained a yield of 0.001 per cent. of a crystaline substance "thyroxin" with all the activity characteristic of the gland. See Fig. 5.

Harrington (1926) by a greatly simplified method extracted 0.12 per cent. from the fresh gland—and subsequently, together with Barger (1927) synthesized the same substance. The work was carried out with funds of the Rockefeller Foundation in the laboratories of the University College of London and the University of Edinburgh.



5. Thyroxin-Crystal of Kendall's own preparation.

Thyroxin, according to Barger, is related to di-iodotyrosine, occurring naturally in sponges and corals. Two iodine atoms replace two hydrogen atoms of the benzene ring in the amino acid tyrosine. If we take two molecules of iodotyrosine, split off the side chain in one molecule and replace the phenolic hydrogen by the benzene nucleus in the other, we have thyroxin.

According to Barger, thyroxine as such is not present in the thyroid gland. As an amino acid it is combined and set free by trypsin resisting further attack. It can therefore be given by mouth. The substance obtained by alkaline hydrolysis as well as synthesis is racemic (showing no optical rotation). The author plans to prepare the lævo- and dextro-thyroxin for subsequent testing which one is the most active.

Function:

"Every cell in the body responds, states Kendall of thyroxin action, the dried thyroid can do nothing more than thyroxin does; the effects are the same in every way, resulting in virtually 100 per cent. of cures." Injection of thyroxin increases the heat production, due to stimulated chemical changes (metabolism); this is a specific effect. The pulse rate and nervous irritability are increased, as are the output of carbondioxide (resulting from the burning of carbon in the body) and the amount of nitrogen eliminated.

Kendall's work has been verified and accepted by the medical profession. Through its decisive influence upon our general well being thyroxin is probably the foremost hormone. As the dried thyroid preparation, it benefits all such cases, where the body glands function poorly or not at all, *e. g.,* in undeveloped, mentally deficient,

6. a. Fifteen year Cretin fully cured after seven years thyroid treatment. After v. Jauregg.
b. Woman, suffering twelve years from gland deficiency disease, cured after seven months treatment with thyroid-extract. After Murray.

idiotic, deformed, goitrous people—and especially children. See Fig. 6a.

The sleep of winter dormant animals can be shortened and prevented by injection of thryoid extract—effecting an increase in iodine content of their thyroid gland and a more adequate heat regulation. Human baldness coming on with advancing years is evidently due to the insufficiency of the thyroid secretion. Dr. Crew, Professor of Edinburgh University, experimenting successfully with hairless mice, concludes: "If man could be kept under the same controlled conditions as mice during an adequate period of observation, science would no doubt solve the problem of baldness in man." See Fig. 6b.

Thyroid deficiency is especially prominent where the vegetation and atmosphere are practically void of iodine—(certain midwestern sections of this country, the Alps, Switzerland). Iodine occurs

abundantly in seaplants—algæ—from which it is extracted. In inland sections, therefore, goitre is more abundant. Of fifty-four dull, sickly school children in grades two to eight in Chicago, 84 per cent. had goiter, adenoids or tonsil defects. Though parents were informed that the children needed attention, in 80 per cent. of cases, either because of poverty or indifference, nothing was done to build up their health.

The iodine content according to experiments made in Weinstephan, Germany, can be increased through fertilization with mineral iodine in such plants as clover, beets, potatoes and grass—and through feeding these plants the iodine content in animals and their products will become larger.

The promiscuous use of iodine in community administration according to Dr. Hartsock, of Cleveland, Ohio, disregards physiological facts regarding the effect of excessive iodine on the thyroid gland—causing hyper function. "The use of iodized salt in particular should be discontinued or limited absolutely to periodic table use by children under the age of puberty."

The parathyroid is a small gland embedded in the thyroid—usually four being present in the human body. See Fig. 4 and Fig. 2, b and d.

2. PARATHYRIN: EXTRACT OF THE PARATHYROID ("LIME GLAND")

Preceded by various less successful workers, J. B. Collip, of Alberta University, Edmonton, Canada, 1925, obtained an active extract. "Collip's Hormone," upon boiling the gland with 5 per cent. hydrochloric acid. At least one commercial preparation is marketed under the name parathormone, under the authority of the University of Alberta, manufactured according to Collip's process.

Hjort and coworkers verified Collip's findings and obtained similar active extracts from bovine glands.

Davies and coworkers, 1926, found the hormone extract of the parathyroid forms a picrate, which is insoluble in water, but soluble in 70 per cent. acetone, convertible into a hydrochloride. The active hormone may be prepared by the acetone picric acid method which is also used in the preparation of insulin. Pending further proof, the close relationship, if not identity of parathyroid hormone and insulin are indicated.

Recent reports refer to the hormone as a regulator of calcium metabolism, to its action as a calcium mobilizer in the blood stream. It also increases, especially if given in overdosage, organic phosphorus in blood and serum. It relieves tetanus. Success in treat-

ment of infantile paralysis has been mentioned. Ogawa of University Keyo, Japan, shortened to one-half the healing time of bone fracture of rats—with the increase of calcium and phosphorus in the blood. Finally parathyroid extract clots blood readily and may be helpful in blood coagulation.

3. ADRENALINE: HORMONE I OF THE ADRENALS ("FIGHT OR FEAR GLAND")

The human adrenals represent two small glands about one-seventh ounce in weight located near or above the kidney (adrenal or suprarenal-epinephral) with a rich blood supply. The gland consists of (1) the marrow-like medulla yielding adrenalin (epinephrine, suprarenin), and (2) the outer organ "cortex" essential to life.

Oliver and Schaefer (1894) focused interest upon the glands—finding that medulla extract injected into the body increased the blood pressure. Brown Séguard, the pioneer in sex gland studies, distinguished himself also in his field, removing the adrenal gland from various animals, thus causing death of rabbits, guinea pigs, dogs and cats within thirty-seven hours. He considered the adrenals more important to well-being than the kidneys.

Marked progress in the isolation of an active hormone was made by the Austrian Fuerth (1897-1898) and independently by Professor Abel of Johns Hopkins University 1898-1901. Takamine, a Japanese, using essentially Abel's method, and adding ammonia in excess to a more concentrated solution of the gland (Abel's acid protein-free extract), obtained adrenaline in crystalline form. Five years later, Friedman, a German, synthesized it (by action of methylamine upon chloroaceto pyrocatechin), the resulting compound yielding adrenaline on reduction.

The synthetic adrenaline is racemic (d. l.) adrenaline—optically inactive. The natural adrenaline, lævo-rotatory adrenalin, is fifteen times as strong on blood pressure as dextro-rotatory adrenalin.

Adrenaline (epinephrin) has a benzol nucleus; the molecular formula $C_9H_3O_3N$, and represents a derivation of pyrocatechin—an amino-alcohol called lævo-methyl amino-ethanol-catechol.

Function:

The outstanding function of the adrenal, medulla and cortex, according to Prof. Ch. Sajous (1925), is their significance in the production of body-heat.

Adrenaline affects the body tissues much like the sympathetic nervous system. There is hardly a more useful substance in medi-

cine. It causes a contraction of the arteries, being the most powerful vasoconstricting drug known. It checks the flow of blood, used locally for arresting capillary hemorrhage. In shock and collapse showing less blood in arteries and more blood in veins than usual, adrenaline administration tends to restore equilibrium. It produces a bloodless, bleached area, giving the surgeon a clear field of operation, and has therefore been used together with anesthetics. It is effective in eye, nose and throat surgery. In mental disorder adrenaline injected into the conjunctive (a membrane lining the eyelid and covering the eyeball), a marked dilatation of the pupil occurs after a few minutes. It is further effective in bronchial asthma, if locally applied as a spray to the larynx, or injected into the muscles, it arrests promptly asthmatic paroxysm. It increases sugar in the blood when injected, acting antagonistic to pancreatic hormone, thus helping to regulate body equilibrium. Adrenaline is increased in the blood upon emotional outbursts. It may also be a remedy for nearsightedness. Dr. Meyer Wiener, of St. Louis has recently tried out minute quantities of this powerful drug on patients with progressive shortsightedness and (before the American Medical Association) states his belief in its value in correcting this derangement of vision.

CARDAISSIN-HORMONE II OF THE ADRENALS

H. G. Cameron, of Saskatoon (Saska., Canada), within the last month reported the isolation of 10 grms. cardaissin from 2000 cow adrenal glands. No further data are available to the writer except a note of stimulating heart action in pneumonia and anoxemia, and the report that, through counteracting chloroform poisoning, it renders some operations less dangerous.

INTERRENALIN: HYPOTHETICAL HORMONE OF THE OUTER LAYER CORTEX

J. M. Rogoff and G. N. Stewart, from the Cushing Laboratory of Experimental Medicine, Western Reserve University, report recent experiments upon the effect of interrenalin on period of survival. Clear extracts, made from a dog's fresh adrenals, with 0.9 per cent. solution and glycerine, were injected intravenously on alternate days, into dogs after removal of their adrenals. The injections produced no obvious ill effects. Whereas dogs—after adrenal removal and without extract treatment—lived in no case longer than sixteen days; those treated lived considerably longer, one surviving seventy-eight days after removal of the adrenals.

Adrenalin had no considerable effect on prolonging life.

Autonomin (Hormone E).

Its presence in the adrenals and its action antagonistic to adrenaline is not confirmed.

The Pancreas gland, located below the liver, shows within its open glandular tissue, excreting digestive ferments, rather well delimited cell units, "islets of Langerhans," furnishing the endocrine secretion.

4. INSULIN: THE HORMONE OF LANGERHANS ISLETS ("SUGAR GLAND")

The connection of the pancreas and the abnormal secretion of grape sugar in the urine (diabetes mellitus) was established in 1889. However, the presence of an internal secretion then provisionally called "insulin" was not established until 1908 by Schafer. This secretion was not isolated in spite of many attempts, inasmuch as digestive ferments such as trypsin, present in the pancreas, interfered with the extraction of the active hormone. Banting, of Toronto University, Canada (see Fig. 3a), devised a simple but ingenious method. Experimenting with dogs, he cut the duct in the pancreas supplying the interfering ferments. The extract from such a pancreas reduced the blood sugar content in diabetic animals and thus a discovery was made which quickly became known the world over. Soon it became possible through simpler methods of extraction, to prepare in quantity from the fresh pancreas an extract containing the internal secretions of the islets of Langerhans free from the proteolytic enzymes.

In the meantime methods for the accurate estimation of sugar in the blood were perfected, permitting the full utilization of Banting's pancreatic extract—a true romance in medicine.

Concerning the composition of insulin, the American worker Abel and Casimir Funck the Pole, from the Warsaw State Institute of Hygiene—and discoverer of "vitamines," must be emphasized.

Abel's Work.

As a result of numerous attempts to crystallize insulin, Abel concludes "the methods usually employed in fractioning and purifying biological mixtures have been found quite useless in the attempt to separate the hormone from the numerous impurities that are associated with it in even the best of the extracts employed in medical practice." He employed only weak bases and acids and obtained such an alteration of solubilities that impurities either fell out or remained in solution, while the hormone in each case took the opposite course. Further elimination and precipitation of impurities was affected with an acidulated solution of brucine accompanying strychnine in strychnos seed.

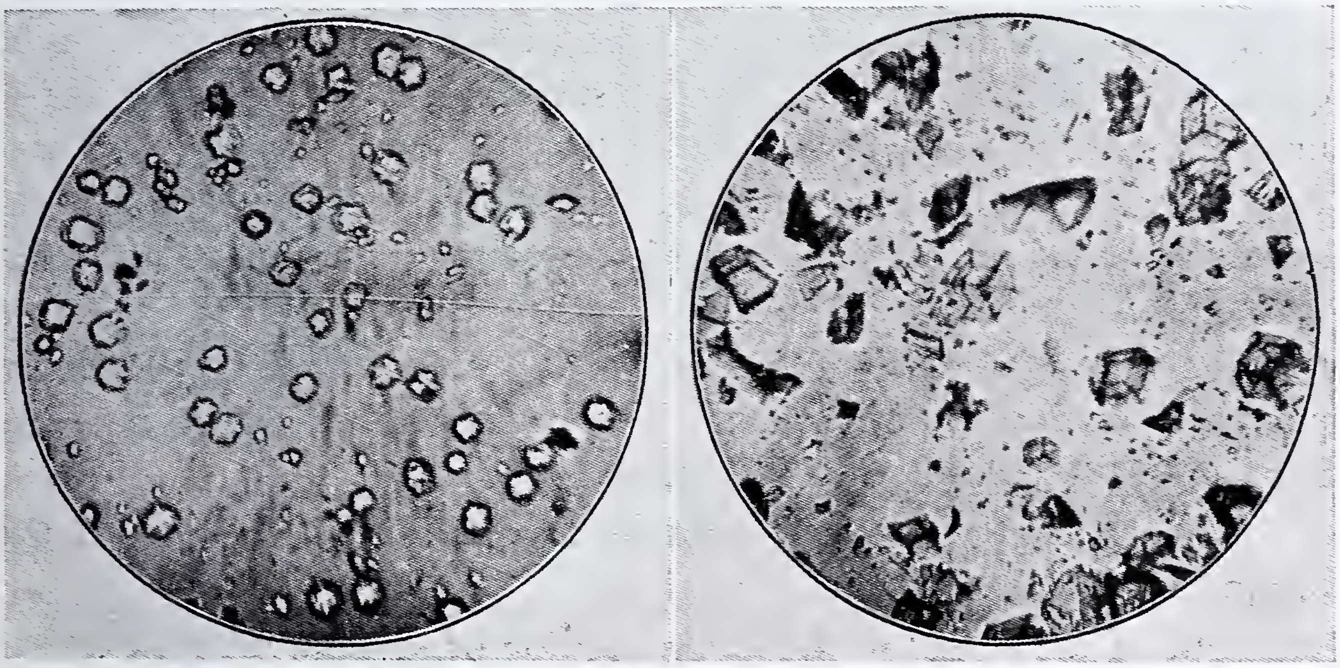
Thus in 1926 Abel obtained crystalline "insulin" hundred times as active as the insulin manufactured. The crystals melt sharply at 233 degrees Celsius.

Further work resulted in the isolation of two types of crystals (see illustrations). "We have," states Abel, "thus far obtained no evidence in favor of the possibility that our insulin consists not of a single substance, but in reality is composed of two substances."

Funk's Work.

Funk assures the presence of three substances:

The true pancreatic hormone A obtained in crystalline condition.



7. Insulin-Crystals from Abel's own preparations (400 times magnified).
Left: Precipitate from acetic acid with N/6 pyridin.
Right: Precipitate from sodium phosphate solution with N/6 acetic acid.

The anti-insulin B.

The co-insulin C.

A acting like the old insulin, constituting about 50 per cent. of the total insulin.

B anti-insulin representing a new hormone of complicated action—and one not fully understood. When injected or given by mouth, it causes great increase in blood sugar—resulting finally in death (rabbit).

In diabetics there is possibly too much B (anti-insulin) and sufficiency of C (co-insulin).

In non-diabetics there is a lack of co-insulin, without which perhaps A cannot act—or an excess of B (anti-insulin).

Degrez and co-workers (1927) conclude that in some cases the administration of insulin does lead definitely to resumption of function by the pancreas, and therefore to a cure of the disease. The essentials for success they consider to be (1) insulin early in the game and in full doses, (2) administration of what they call an optimum dose, (3) possibly years of treatment, (4) the very closest surveillance of apparently cured patients.

Function:

Except in a few really milder cases, insulin evidently does not cure diabetes—though it makes the diabetic's life worth living (Stephenson). Insulin supplies to the organism its deficient hormone, enabling the patient to metabolize foods hitherto poisonous to him; quite different from Allen's (1915) starving or fasting treatment—until the patient's urine becomes sugar-free—and followed by carefully adjusted diet—so as to avoid renewed secretions of sugar. Insulin also allows of surgical operations being performed on diabetics, formerly a very risky procedure. It may prevent the passing into the coma stage. Before insulin was known, diabetes in children practically always proved fatal. The use of insulin has completely revolutionized the diabetes treatments.

The specific defect in diabetes is an inability on the part of the organism to utilize glucose.

One of the stages in the decomposition of glucose with six atoms of carbons into carbon dioxide and water is its conversion into lactic acid with three carbon atoms; the substitution for glucose of a sugar with three carbon atoms, structurally different from lactic acid such as dihydroxyacetone, commercially "oxantin" was tried—but was directly utilized only in mild cases. An equilibrium appears to exist between the dihydroxyacetone and glucose—controlled by insulin.

In its absence dihydroxyacetone is rapidly converted into glucose.

Gluchorment.

Insulin is easily decomposed by certain digestive ferments and must be injected. Van Noorden, of the University of Frankfort, Germany, now announces the preparation of gluchorment, obtained through fermentation from the pancreas. This substance can be given by mouth—for the treatment of diabetes.

Synthalin.

This synthetic substitute for insulin was introduced in 1927. Watanabe in 1918 had observed lowering of blood sugar as a result of guanidin. Frank (1927) of University clinics, Breslau, Germany, experimented with guanidin compounds—and synthetic alkaline derivatives, such as "synthalin." This can be given by mouth—appears slower in action than insulin—its effects last longer, are cumulative—of possible service in conjunction with insulin, rendering this less necessary. Still on trial, causing toxic effect in some persons suffering with abdominal troubles or with tuberculosis, although fifty cases, light and somewhat serious, were reported a year ago as successfully treated. In this connection it is interesting that various workers, Collip, Glaser and Halpern (1925) of Wasicky's pharmacognostic institute in Vienna, considered insulin as a guanidin compound.

Vegetative Insulins.

Plant substances controlling—insulin like—the blood sugar are briefly discussed under plant hormones.

Metals Active in Pancreas Extract:

French authors, Bertrand and Macheboeuf, found much cobalt and nickel in various animal pancreas glands. They consequently attribute to them a real importance in the diabetes treatment with insulin.

5. PITUITRIN: THE HORMONE PRODUCT OF THE PITUITARY ("DWARF AND GIANT GLAND")

The oval gland, often referred to as "Pituitary Body" before its glandular nature was known, is located at the base of the brain in a depression of the skull. The human gland is but small, like a pea, weighing only 10 grains. The bovine gland is 4 times heavier. The whale gland, believed to be the largest pituitary of any, has been selected by Dr. Dunn of the University of California for the extraction of the hormones.

The gland consists of two main parts, the larger called anterior or front, the other posterior or back lobe—and an intermediate portion.

Back (Posterior) Lobe—Extract:

Abel and his co-workers have isolated a tartrate of the specific principle, exhibiting all of the diverse physiological activities of a

well prepared aqueous extract. It is present in small amounts—9000 head of young cattle being required according to a manufacturer to prepare one pound of desiccated substance. It is very easily changed by chemical reagents, the purification and determination of its exact chemical nature has therefore been found very difficult.

Other workers have found that trypsin inactivates this hormone, and conclude that it contains a peptide linkage in its molecule; pituitary extract has a reducing effect on gastric secretion, influencing likely the vegetative nervous system.

In stating the function of both the aqueous extract and his tartrate principle, Abel refers to the constriction of the capillaries, the rise of blood pressure, the effect on the kidney, controlling excessive urination, and the extremely powerful stimulation of all smooth muscles. Abel's tartrate proved to be 1200 times more powerful, as a uterus-contracting agent, than the substance (histamine) considered hitherto the most powerful.

VASO-PRESSIN—PITUITARY HORMONE I

This active hormone isolated by Dr. Oliver Kamm and associates of the research laboratories of Parke, Davis and Company, in practically pure form, causes rapid rise in the blood pressure and a constriction of the arteries.

OXYTOCIN—PITUITARY HORMONE II

Another active hormone available in practically pure form, was isolated by the same workers. This substance excites a violent contraction of the muscles of the uterus.

Front (Anterior) Lobe Extract:

Tethelin, the substance (lipoid ?) extracted by Robertson, has not yet been isolated as a pure hormone. Inasmuch as the aqueous extract produces striking effects in the food exchange (metabolism) and growth of animals—from which the gland had been removed, we have likely a specific growth promoting substance present.

$\left.\begin{array}{l}\textit{Atuitrin}\\ \textit{Pitglandin}\end{array}\right\}$ These are obtained from the anterior lobe and have not been confirmed.

Vitamine X—the Giant Maker—A fluid from pituitary gland injected daily into animals, is claimed to produce giants of their kind. No further report or confirmation is at hand.

(*1*) *Feminin, the female Hormone.*

6. SEXUAL HORMONES

Fellner (1927), reported the isolation from ovaries, placentas, as well as the male sexual organs, of a new hormone. This, an oil-like substance he called feminin, inasmuch as it produced female characteristics, when injected into the male body. It develops the breast glands, and leads to degeneration of the male sexual organs. Injected into female organisms, it produces menstruation, enlargement of the uterus, and the mammary gland, sufficient for milk production. The presence of feminin in the male glands as well, causes Fellner to assume the presence of two hormones in the normal sexual glands, one with male the other with female characteristics. Both being present, he attributes to normal individuals not only the properties of their sex, but also certain characteristic of the other sex. If this relation is disturbed, abnormal conditions prevail, leading even to homosexual perversities.

Folliculin.

Probably identical with Fellner's feminin is the hormone "folliculin" isolated by Zondek (1926). The ovarial hormone was obtained from the ovaries where its presence is restricted to certain outer tissues. It occurs also in the corpus luteum, the well-marked yellow body within the pregnant ovary, but disappears from it after menstruation; the placenta, especially, contains large quantities, which fact suggests its significance as source of production. The hormone is abundant in the blood of the pregnant person, and occurs also in the blood of the infant's naval cord. The physiological effects obtained were similar to those of feminin, already cited.

Ovarian Follicular Hormone.

This substance or extract studied by Frank and co-workers, as well as Allen and co-workers of the University of Missouri, within the last years, is likely the same product. Allen states (1926): "The ovarian follicular hormone exerts a growth inducing influence upon the genital tract which raises it to maximum function including secretory activity of the glandular epithelium. It also bears a causal relationship to mating instincts.

SPERMATOIN OR SPERMIN, THE MALE HORMONE

Little is known of the nature and effect of this hypothetical hormone assumed to be present in the male reproductive organs. The few reports given are indefinite and conflicting.

Sexual Hormones and Bird-migration.

Novel experiments were made by Dr. Rowan of the University of Alberta, Canada. Hardy birds, "Juncos," were trapped in the fall, one group was placed in a birdhouse exposed to daylight only, the other also to electric light. In midwinter the sexual organs of the birds kept in the specially lighted house had been transformed to conditions found in the spring in migrating birds. Of 100 birds released from this group only few were recovered. The birds kept without artificial light, were found with sexual organs in the state of quiescent minimum winter activity—and showed no desire to migrate.

THYMUS AND PINEAL GLAND EXTRACTS

From these glands, one (thymus), located in the chest, the other near the brain, no active principle has as yet been isolated—their nature and function therefore is not fully assured.

II.

The Need for Harmonious Interplay of Hormone Glands

An important chemical correlation is now generally recognized in the work of hormones, playing a definite rôle in the cooperative work of the glands—nerve and blood system. Dr. Hammett writes thus about interglandular associations: The stellar rôle hitherto held by the thyroid must be given to the adrenals—these structures are positively and specifically correlated at the usual level of thyroid activity with all of the other glands of internal secretion save the pituitary gland in both sexes.

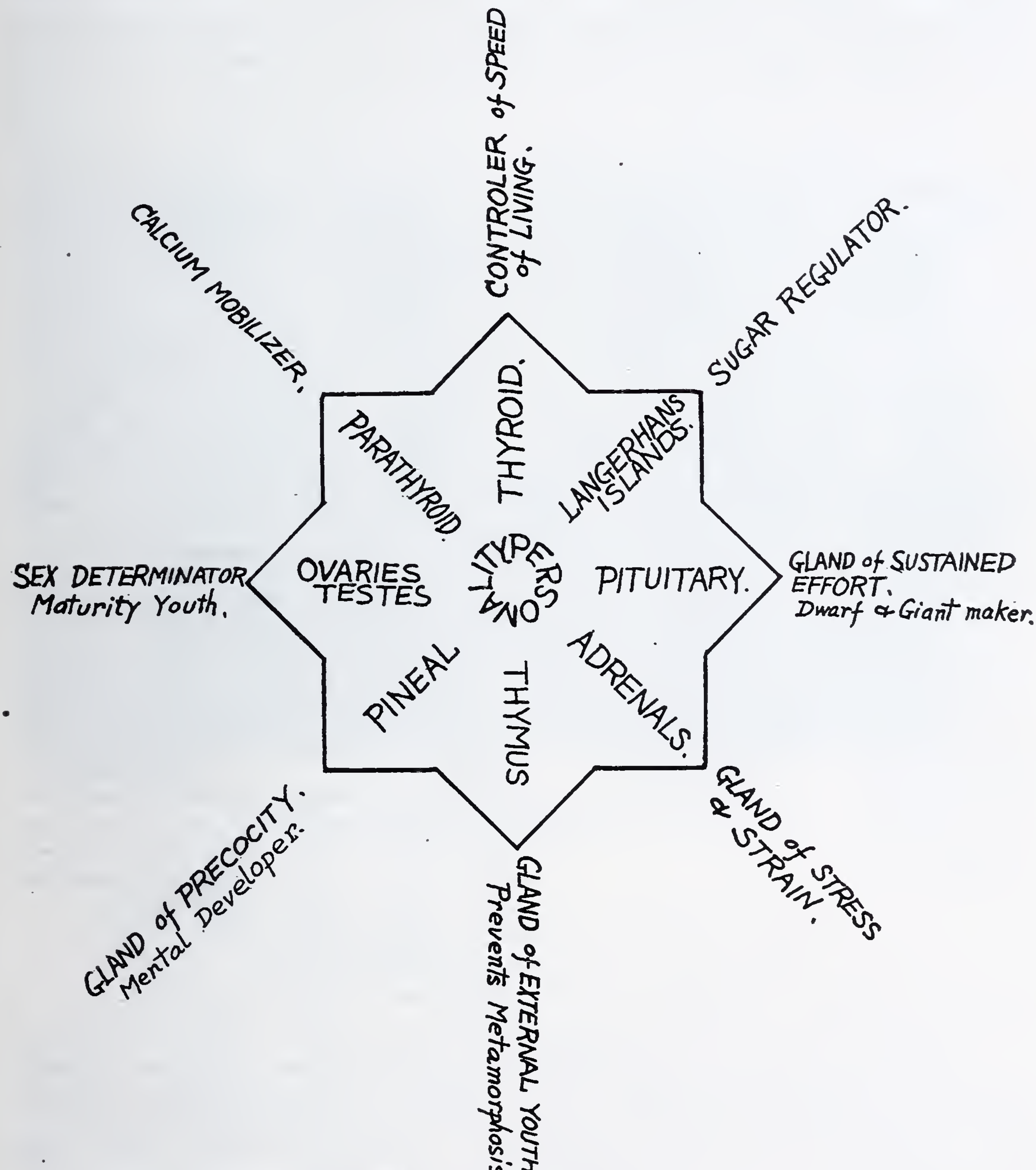
A BIOCHEMICAL MIRACLE

Temperament, normal behavior, personality are changed, if, as many writers have suggested there is no adequate synchronization; if there are members who fail to work harmoniously in this biological league of endocrines.

The time, however, suggests Berkeley, to say the least, is not ripe for pleasing generalizations. Almost any layman, even newspaper editors and the directors of physical culture institutes—is at liberty nowadays to enlarge upon the marvelous interrelations of the ductless glands—and the domination of personality by this and that combination of secretions. The pituitocentric, thymocentric-thyrocentric people belong as yet only to fireside legend. He agrees with G. N. Stewart that "the physiologist in reading many papers by clinical endocrinologists can scarcely escape the feeling that here he has broken through into an uncanny fourth dimension of medicine, where

the familiar canons and methods of scientific criticism are become foolishness, where fact and hypothesis are habitually confounded, and nothing is but what is not."

Yet! Remedies within us lie, that we ascribe to Heaven.—*Shakespeare.*



8. Biological League of Endocrines.

Nature and perpetuation of life is dependent on endocrines, which bid fair to place therapeutics on a scientific footing, and may in the end, says Sajous, furnish medicine as a whole. He urges glandular treatment of the prospective mother with inadequately functioning endocrine glands; the number of children born feeble-minded can thus be greatly re-

INHERITANCE WORKS BY BROAD SWEEPS

duced—as well as that of criminals, now estimated at one million (in the united States alone), half of whom are criminal because feeble-minded. He recites as an example, the case of a family in which three children were born—all idiotic. Clear evidence of glandular deficiency was found in the mother. She was placed under glandular treatment, to protect the child expected in about six months. When that baby was born it was normal. At the age of five it was a fine, bright boy, normal in every respect.

That other glandular diseases or insufficiencies may be inherited can readily be seen from the chart enclosed.

Grandfather
(Obesity and Gout)

Son
(Slight thyroid swelling, later light diabetes with light Basedow's symptoms.)

Daughter
(Slight thyroid glandular swelling, climacteric psychosis, light diabetes.)

Daughter
(Slight Thyroid glandular swelling, manifestations of hyperthyrosis.)

Son
(Obesity)

Granddaughter
(Severe exudative diathesis, later bronchial asthma.)

Granddaughter
(Obesity.)

Granddaughter
(Pronounced lability of the ductless glandular system, great variations in the body weight during pregnancy, light Basedow's symptoms, great sensitiveness against cocaine.)

Granddaughter
(Likewise lability of the ductless glandular system, migraine, convulsive heart attacks.

The exact cause for inheritable malformations such as midgets, is as yet unknown, though it is attributed to a pluriglandular disease. The same is true of the disease like change from one racial type into any other, *e. g.*, mongoloid—or nigroid—type, suggesting as has been done by others—the dependency of the racial type upon slightly different gland structure or function.

Mass Effects.

The administration of thyroid, pineal, pituitary and the proper sexual gland extract caused a distinct clinical improvement—says

Berkeley in "Mongols." See Fig. 9. "Except for the pharmacological antagonism between insulin on the one hand and adrenalin and pituitrin on the other, there are few or no therapeutic incompatibilities between the various hormones that need give us pause at the bedside. When the patient is carefully watched pluriglandular therapy can at least do no harm." Striking indeed are the results obtained by Gudernatch with various glandular extracts fed to tadpoles. See Fig. 2, c.

9. Sisters: the healthy, three years old; the mongoloid, six and one-half years old; before and after glandular treatment. After Falta.

III.

Plant Hormones—Agents of Plant Life

The story of plant hormones is less complete than that of the animal hormones. The subject is equally interesting, if one realizes as we see later, the effect of animal hormones on growth and reproduction of plants, especially the effect of hormone like plant substances on man's digestive, circulatory and nervous systems.

While we lack blood circulation and a nervous system in plants, we have, nevertheless, correlation of parts through the plasma connections existing between all cells.

As early as 1880 Sachs, assuming the existence of organ—and especially flower forming substances, attempted to demonstrate their presence. In 1910 Fitting first applied the term hormone for flower and fruit forming substances.

Errera (1904), referring to the upward growth of lateral shoots possible only after the removal of the apical bud of the main pine stem—suggested an internal secretion by this bud. "The main branch is the tyrant—preventing the enslaved side branches, in spite of their desire, to grow erect."

1. Growth hormones.

As no Hormones affecting growth and cell-division have been isolated, mention can only be made of morphological changes and influences, suggesting their presence. The growth hormones are as yet hypothetical substances.

Errera's apical and Fitting's floral secretion have already been mentioned. Pringsheim suggested that seedbuds (poppy) at a certain stage of development excrete into the tissue a substance which affects the transformation of negative into positive geotropism of the stem. Loeb (1916) see Fig. 3, in connection with his work on Bryophyllum calycinum advanced his theory of root—and stem forming hormones. He believed in the influence of the leaf upon root formation and geotropic curvature through hormonaction. He assumed a flow of certain possibly specific substances from places, where dormant buds are ready to grow, or the prevention of such a flow toward those dormant buds. Goebel humorously referred to Loeb's substances and their flow as "pictures."

2. Division Hormones.

Haberhandt (1921), undaunted, and supported by the view and results of other workers, assumed the production of hormones, affecting cell division in embryos or meristematic tissue, in normal or abnormal reproduction, in regeneration, in callous and wound cork formation. He believes that the companion cells of the sieve tubes are the organs of inner secretions, forming the hypothetical division hormone and possibly other hormones. Their transportation is effected in the sieve tubes as well as possibly in lactiferous (milk) tubes.

3. Effect of Animal Hormones upon Plants.

The limited investigations thus far made by various workers are briefly reported by Raabe:

Thyroid substances stimulated yeast growth and fermentation;

they delayed root growth of certain bulbs (onion?), increased that of the hyacinth bulb. Adrenalin increases sugar transformation in wheatembryos. Insulin and glucokinin, in low concentration, stimulate root and bud development and chlorophyll formation of cornembryos—evidently causing increase in assimilation. While fresh pituitary and thymus glands delayed the development of hyacinth bulbs, pituitrin hastened growth to some extent.

4. Sexual Hormones.

Various female organs of plants, especially powdered pussy willows and water lilies yielded to Zondek extracts which stimulated again the sexual instinct in animals made sexualy inactive through operation. Similar experiments were made with yeast extracts—Feminin was found in flour, oatmeal and rice. (?)

5. Vegetable Insulins.

Substances with insulin like action, reducing blood sugar have been obtained from many plant products in various amounts. Dr. Allen of Morristown, N. J., isolated his myrtillin from blueberry leaves. Insulin-like substances are aso reported in flour, oatmeal and rice, oats, spanish beans, sugar beets, cabbage, celery, lettuce, spinach, orange, lemon, grapes, grassleaves. Brugsch and Horsters found especially large amounts in acorns,—wheat, rye and corn, and suggest that where plant (seed) insulin functions in the synthesis of any starch, it is likely identical with animal insulin.

6. Ephedrine—Adrenaline-like.

Ephedrine, was isolated forty years ago by Magai from a Chinese shrub "Ma Huang," used medicinally in China for several thousand years. It is closely related to adrenaline in chemical composition, occurs in four isomers, all of which have been isolated and synthesized. Only the optically active lævoform is used medicinally. The therapeutic action is very similar to adrenaline—though ephedrine is often preferred, as it is more stable, is active, when given by mouth, and the increase in blood pressure is more persistent.

Summary

Hormones—a fascinating subject for all mankind—are the very basis of things that make life worth living. Youth—Man—

and Womanhood, temperament, personality, beauty and harmony in mind and body.

Hormones, more important than vitamines, the food deficiency products—as the chemical contact men, correlators and harmonizers, effecting the cooperation of blood and nerve system and through them of the organs—and assuring of proper functioning of the organism of the whole—animal—as well as likely plant!

The knowledge of hormones is young and incomplete. The practitioner and surgeon, the physiologist and clinical worker nevertheless have collected a wealth of data—some contradicting, many confirming. While the plant biologist strangely holds back, the biochemist has joined the gland workers. Rapid chemical process is thus being made. Three hormones—adrenalin from the gland of stress and strain, thyroxin, the regulator of vital processes, and insulin, the magic sugar tamer—have been isolated in pure crystals. The first two have been made artificially by the laboratory worker.

Glands are no longer thrown away by packers and butchers as worthless waste. Methods are still needed to establish the real worth of some; the writer, as biochemist, is especially interested in this field and has made promising progress both in the improvement of microanalytical apparatus and methods.

In this age, craving for personality, perfect health and permanent beauty, much is claimed for glands and their extracts, which is clearly unwarranted. For instance the promiscuous internal use of iodine in one form or another such as iodized salt. esp. for adults has been rightly condemned. Health authorities must prevent excesses on the part of the exploiters or the well-meaning half-educated lay.

School authorities and parents must work hand in hand to effect more frequent and more thorough medical inspection of the young—so that the inflicted child may not grow up crippled somewhere with defects—inherited or not, in intellect or in body—which man can now control.

Plant Hormones.

The hypothetical roots, branch, flower, fruit-forming hormones, the cell dividing, the callous—and wound-healing hormones have not as yet been isolated. Work in this field on Digitalis and other plants as well as apparatus useful in the study of hormones is in progress at our laboratories and experimental gardens. Adrenaline-like and

insulin-like substances have been discovered in plants. We have thus another striking example of similarity in the chemistry of plant and animal life.

Research in the fertile field of hormones as life agents is going on. Over 3000 publications were contributed last year by active workers—the number is rapidly increasing.

SEEKERS.

Alas, man's untamed wish
  —outstripping yet his deed—
Spurs his creative mind
  To e'er search for the lead!

ARNO VIEHOEVER.

EPIDEMICS—MAN'S MOST DEADLY ENEMY

By Louis Gershenfeld, Ph. M., B. Sc., P. D.

Professor of Bacteriology and Hygiene, Philadelphia College of Pharmacy and Science

IF I VENTURE once more to speak on a topic, which I may have briefly touched upon at a previous occasion, it is because it is our duty to help form a more enlightened public opinion, and to guide and quicken the awakened interest in science.

Prof. Louis Gershenfeld

Science, as defined briefly by Dr. David Starr Jordan, is "organized human knowledge" or "human experience tested and set in order." By introducing the best outlook of science into life, the ordinary happenings of our everyday routine will be filled with new beauty and wonder; and we will know not only how to make a living, but what is more important, we shall know how to live. There are many who do not know whether to regard science as an amusing toy for the scientist or as an indispensable factor in modern civilization.

The old saying "that what one doesn't know, one doesn't worry about" should not be practiced these days. Past experience has taught that the acquisition of knowledge is the best way to do away with worries, mistakes and various ills. The possession of knowledge gives one a means of looking forward and preparing to meet conditions that the future will produce. The difference between knowing and not knowing depends not only upon the method of presentation of the particular subject, but also upon the method of approach by those eager to learn. "We learn to do only by doing" is also best practiced voluntarily, rather than by compulsion.

There is a familiar axiom, which was expressed four centuries before Christ: "Life is short and art is long; the occasion fleeting; the experience fallacious, and judgment difficult. The physician

must not only be prepared to do what is right himself, but also to make the patients, the attendants and externals cooperate." These lines can be repeated on behalf of the public health worker as being just as opportune today, even though we are living in an amazing and more enlightened epoch. Time has not altered the value of this advice from a voice 2400 years ago. Despite centuries of philosophical guidance, these words should be taken to heart by those living in this day of material wonders, and who desire to get much out of this life before the brief span closes.

Are you one of those who has become accustomed to the idea that epidemics are inevitable visitations? Do you for a moment pause to consider what are the conditions that must be fulfilled prior to the coming of a plague and are you ready to do your share in case of an approach of an epidemic? You may not be able to postpone death unless you possess such knowledge. If epidemics had not been controlled during the war as effectively as they were, there might have been a different story to relate. It is no accident that one child develops scarlet fever and the other does not; or that one develops a mild attack, and the other a severe attack of a disease, even though both were exposed to that disease under identical conditions. You provide yourself with an umbrella to protect you against the rain, snow implements to get rid of the snow; you vote for the construction and upkeep of battleships, which, with their officers and crews of many thousands, require a stupendous outlay of money—far, far in excess of that allotted for the introduction and upkeep of sanitary conditions, and yet you are incurably optimistic, and only take account of an epidemic disaster when it actually arrives. It is about time that man depended more upon his reasoning powers than upon his emotions.

It may seem cheaper at the beginning to neglect proper sanitary control (because of the initial outlay of money). But is it cheaper in the long run? Let the health authorities ask for a few thousand dollars to avert the approach of an epidemic, and in many cases the appropriation is denied them. Narrow personal prejudices at times becloud an issue, and defeat is the result. But after the arrival of the epidemic, there is a different picture and story. Money is made available in amounts many times greater than the sum required before the appearance of the disaster.

The loss of life from wars has generally been considered a necessary sacrifice made in the cause of human freedom. The upkeep of armies and navies is supposed to keep these losses down to a minimum. For those lives lost by epidemics, the average individual has assumed a somewhat peculiar attitude, one that is largely tinged with helplessness and fatalism. By introducing methods of modern sanitary science and paying for their upkeep just as we support our army and navy, a great stride will be made in solving the problem of wiping out epidemics, or at least in keeping the loss of life down to a minimum. Sanitarians are hampered by lack of funds and equipment. As soon as their educational methods and plans are placed on a battleship basis as a part of our daily routine, and individuals display a more serious appreciation and an intelligent cooperative spirit, there will be an even greater saving in the lives of men, with the resultant improvement in general health. This in turn will mean greater happiness and happiness will beget longer life for all.

DISARMAMENT OF THE HEALTH FORCES MUST NEVER OCCUR

Is it possible to evaluate the work of the sanitarians as a distinct contribution to human progress? Have you as layman realized that in trying to advance sanitary science, the sanitarian has no selfish motive? In reality, if the time ever comes when sanitary knowledge will be practiced to its fullest extent, there will be less opportunity for the sanitarian to receive any worthwhile financial return for himself.

Would the Panama Canal have been built if not for the sanitarians? Who made Cuba, Central Africa and the many tropical countries habitable? The same organization, affected by sanitarians to deal with the foregoing problems, is always capable of dealing with disease, if the means will be made available. Yes, it is the man of science who ultimately is to decide the fate of a nation.

From one to two billion dollars are spent annually to advertise commodities. This money does not make the products any better. But if spent wisely, you are led and made to think and feel, that the commodity is good, and then and only then does the product actually become good.

Scientists unfortunately do not have at their disposal the financial means for advertising, or in other words to get you in the proper state of mind to think about their problems, introduced for your benefit. Also you who buy the advertised commodity eventually pay for the advertisement of such commodity. The scientist, however,

has no means of collecting for any advertisement. Commercial advertisement is introduced primarily with the hope of a financial return being received by the producers, while the consumer's interest is in reality only of secondary consideration. The opposite is the case in the presentation of scientific information to the general public by the scientists.

ADVERTISING HEALTH

We need more advertising and the spreading of literature giving medical, sanitary and scientific facts impartially. The many beneficial societies and insurance companies can and should act as distributors of such information. Instead we have patent medicine, food and other concerns presenting in advertisement scientific sounding facts, which are objectionable and misleading.

Flitcraft's Compend for 1926 reports that sixty-three of the prominent life insurance companies have admitted assets (as of January 1, 1926) of over eleven billion dollars. Add to that the many companies not rated as prominent, we can easily place the estimated figure close to the fifteen billion mark. "New Paid For" business during 1925 amounts to twelve and one-half billion dollars. Add to that business to smaller companies, and the total will be close to fifteen billion. Premiums on this are approximately $600,000,000. The Thrift Publishing Company of New York City publishes a chart, according to which 251 life insurance companies had a premium income during 1925 of approximately two and a half billion dollars. And this does not cover all of them. There are no statistics available as to the expenditure of dues solely for beneficial organizations. But at a glance, you can readily see that many, many billions of dollars are spent annually to protect and benefit financially the dear ones of the deceased.

Compare this with a recent statement that approximately one billion dollars a year is spent in this country on medicines, doctors and hospital maintenance. Half of this expenditure was for prescriptions and patent medicines (and most of the half for patent medicines), while the greater portion of the whole was for the treatment and not for the prevention of ailments.

Insurance after all is not so much a protection for the individual as for the dear ones of that individual. And that same insurance is sold not really for the humanitarian thought of benefiting the individual, but because a persistent agent, strongly armed with perseverance wants his commission of the premiums (which in the

early years of the policy are very high), so that he may live and carry on. Now, I am a firm believer in insurance. I am willing to agree that the dear ones that are financially benefited are also aided to care better for their health. But are the insurance companies, beneficial organizations and other similar bodies contributing to the welfare and health of their own members in the measure, which the facilities at their command make possible? Should it not be the duty of these organizations to do more than aim to protect the financial standing of the immediate relatives of the deceased? An increase in the interest of health, which they may foster, will benefit them financially to an even greater extent, than they receive today through advertisements as carried on by them. I am not unmindful of the great work which some of these beneficial and a few isolated insurance organizations are performing. But I firmly believe, that if these great bodies in a cooperative effort would apply themselves in a spirit of human service to foster a more effective movement for the appreciation of the fundamentals of health and sanitary regulations, they would exhibit much wisdom and make a signal contribution to the whole cause of modern education in matters pertaining to health.

May not our attention be directed momentarily to the efforts of our government and state along these lines? Are they doing as much as they should? Why did they spend the large sums during the great World War and when peace is at hand reduce the allotment expended for the fostering of health education to a small fraction of that expended for the fostering of health education to a small fraction of that expended in those trying days? Any expenditure which may be made is not an expense. It is in reality an investment, greater than any financial return could possibly bring forth. Misery and suffering, avoidable sickness and untimely deaths are diminished, and the savings of lives are the result, if the health officer is not handicapped by a lack of funds.

When we were forced to take stock of our available man-power, there resulted a revelation, which came as a shock—less than half of our best were fit. Does this not show that everyone needs to be conversant with all factors affecting his health? Surely, such conditions are the same during peace as during war. Then why are we allotting an expenditure of only a small fraction of that which was spent before? Are our authorities realizing their responsibilities? Are we turning our cast iron into rustless steel or leaving it alone to remain cast iron and rust?

Health may be defined as that condition of the body, in which all the various duties are being performed normally, without disclosure of any discomfort.

HEALTH—DISEASE

Disease, on the other hand, signifies the imperfect functioning of one or more of the bodily organs due to some impairment in the structure. This is revealed by a feeling of discomfort, either in the affected part, or throughout the system in general.

A healthy body then is one, which responds favoraby to environmental influences, in contrast to a diseased body, which does not exhibit adequate responsivity.

Diseases were formerly spoken of as "Contagious or Infectious." The former (Contigere—to touch) included all those diseases, contracted by direct contact with the patient or material obtained from the latter, and not disinfected immediately. Infectious diseases (Inficere—to put in) are those contracted indirectly or through an intermediary. A confusion which is prevalent as to the term to use in the various diseases, has influenced the introduction of more exact terms. These are Communicable or Transmissible—by direct contact (those formerly known as contagious)—by indirect contact (those designated as infectious). Just as all contagious diseases are infectious, so most all of the diseases transmissible by direct contact may be disseminated indirectly through an intermediary.

> Example of contagious (transmissible by direct contact) diseases—smallpox, diphtheria, scarlet fever, measles, chickenpox.
>
> Ex-infectious (transmissible by indirect contact) diseases—typhoid fever, dysentery, cholera, etc.

A few isolated cases of a disease occurring occasionally in a particular community is spoken of as an "outbreak" of the disease, or as "Sporadic."

Diseases that are constantly present in certain localities (in small numbers) or are characteristic of a particular area are said to be or spoken of as "Endemic," (En-in, Demos-people).

If a large number of cases of a particular disease occurs at the same time in a given area (being generally prevalent throughout that territory), that disease is said to be "Epidemic," (Epi-on, upon and Demos-people). The exact number of cases which must prevail

before a disease can be spoken of as an Epidemic is not definite, ranging from one-tenth per cent. of the population to 1 per cent. in places having a small population.

If an epidemic disease spreads over large areas as an entire country, continent, etc., at once or at about the same time, the disease is then said to be "Pandemic," (Pan-all, Demos-people).

Acute Diseases are those, the symptoms of which appear suddenly, have but a short duration, and possess definite characteristics.

Chronic Diseases begin with misleading symptoms, usually not characteristic, and of such manifestation, as not to be perceptible. The duration is indefinite. The symptoms throughout the disease are irregular and vary. Chronic diseases may be the perpetuation of acute attacks.

In my attempt to cover in detail the most important group of diseases, that are at times the cause of disastrous epidemics, I will confine myself to a consideration of the prevention and control of the sputum, droplet and air-borne infections. Gastro-intestinal diseases (epidemics of typhoid fever and its kin, dysentery and cholera) have been practically eliminated in this country. The so-called deficiency diseases are a thing of the past, and the few that are prevalent are under control. Malaria and other common insect-borne diseases have been conquered and many other diseases, assuming epidemic proportions, except those that I am about to discuss, have been robbed of their terrors.

Sanitarians are especially concerned with respiratory infections, for their prevention and control is one of the pressing problems at all times.

THE RESPIRATORY DISEASES

Many epidemics, novel in that their exact source is frequently unknown, spread over the country, and reach rather serious proportions in various quarters. Public suspicion may point to certain causes, and it is interesting to observe how the popular mind builds up a clear case of circumstantial evidence against these specific causes. It remains, however, for the sanitarian to make a complete survey. Every diseased individual in badly infected areas is interviewed and watched. Frequent sanitary inspections of the environment are made. Deductions obtained under such scientific guardianship gives more exact information, as to the source of infection. Sound facts are analyzed and correct interpretations made. The scientist under these conditions not only tries to diagnose the trouble, but endeavors to

work out its mysteries and relationships;—how it is propagated and spread, and, if possible, to determine the best means of treatment and prevention. In cities where intensive health saving campaigns have been carried on, there has been a noticeable decrease in fatalities.

What are the sputum, droplet and air-borne diseases, that assume epidemic proportions? They include those diseases in which the infective agent is present in the air (air-borne) or in the secretions of the nose and throat (droplet or sputum-borne). They are influenza, measles, German measles, diphtheria, smallpox, chickenpox, mumps, scarlet fever, whooping cough, cerebro-spinal-meningitis, epidemic or septic sore throat, colds and the sequalae of these diseases.

Let us now consider the direct and indirect factors, that are of importance in the prevention of the spread of these diseases.

Pathogenic (*i. e.,* disease producing) micro-organisms are always lodging on various parts of the body, and still people are not constantly sick. In epidemic diseases, it is also observed, that only a portion of those exposed become infected; and those diseased will show symptoms from mild to the most severe cases. It is therefore evident, that the production of an infection must depend upon influences, other than the mere contact of disease producing micro-organisms with the body. Such influences are regulated and shared by micro-organisms as well as by the host (*i. e.,* the individual upon whom the organisms live).

Concerning the organisms, the first fact that must be considered is that infection depends directly upon the virulency (disease inciting power) of micro-organisms. Don't get the erroneous idea, that all micro-organisms are disease-producing. Also the same species of harmful bacteria may show a marked variancy in disease-producing properties. One of the members may be non-disease producing, while others may possess increasing degrees of energy and pep in their mischief-making. Remember that the bacteria themselves are subject to changes of one kind or another, which, in turn, may affect their virulency, if they possess originally such power of producing disease. Then the number of these disease-producing organisms that may invade the system will also modify or increase the seriousness of a particular disease. But the most important fact, which must be considered, is the path by which bacteria enter the tissues. Many organisms will only develop and exert their disease-producing properties if they gain entrance to that particular part of the body peculiar to each individual group of bacteria. Such characteristics have

resulted in the distinguishing of distinct groups, the most important being the respiratory bacteria (bacteria causing infection of the respiratory tract), and the gastro-intestinal bacteria (organisms causing infection of the gastro-intestinal tract).

Infection therefore takes place as the result of the invasion of the body by disease producing organisms, living in the body tissues, favorable for their existence.

In addition to the individual characteristics of bacteria, the power possessed by them to produce disease depends also upon the nature of the host. A bacterium that is pathogenic for one animal may be harmless to another. The Treponema Pallidum (organism causing syphillis) is non-pathogenic for the commonly observed laboratory animals, but pathogenic for man. Typhoid bacilli fed to man will produce a serious disease, but will produce no effect when fed to cattle.

Other than the previously-mentioned facts, the ability of bacteria to produce disease may be modified by a number of factors, affecting the host, or the body which is attacked. These are known as the predisposing causes. They are conditions which by their influence upon the body predispose individuals to infection. Such conditions are numerous and varied.

The host himself possessing the disease-producing organism in the proper or favorable body tissues may be diseased, producing either a severe infection, confining him to bed, or it may only be a mild attack. Under such conditions, he may go about his routine daily duties. On the other hand, he may be what we know as a "Human carrier." The latter are healthy individuals, who harbor in their system disease-producing bacteria, which may be passed on to others, who because of a lower resistance or vitality, may become diseased.

To lower the incidence of respiratory infections, our main efforts should be aimed at the prevention of the promiscuous transfer of sputum and nasal discharges by the host. The average individual does not understand the danger from the latter and accordingly these secretions are distributed freely and promiscuously. If he was aware of the fact, that the causative agents of all respiratory diseases reside in these discharges, and that the portal of exit is by means of the same discharges, he would perhaps be more careful, and not distribute them promiscuously.

Promiscuous spitting or expectorating should not be tolerated and should be prohibited.

Avoid loud talking. Droplets of saliva containing the infective agent may thus be transferred from one to another, especially through close contact.

The handkerchief should be employed at all times to "screen the sneeze," to smother the cough, and to receive discharges when blowing the nose. Don't use the hands for screening a sneeze or smothering the cough. Keep your hands and fingers away from your mouth and nose at all times, and avoid soiling your hands with the discharges that may be on the handkerchief. Clean your hands thoroughly after they visit the mouth, etc. Cleansing of the hands should be practiced before one partakes in food. I firmly believe that just as the hand is frequently the transmitting agent in food borne epidemics (typhoid, cholera, etc.), (by contaminating food and drink), the hand is to a far greater degree a big factor directly and indirectly in the spread of respiratory diseases.

Many of our epidemic diseases in their most virulent forms have their sources, and also very likely their permanent homes somewhere within the confines of these environments, where we encounter imperfect sanitation, and where personal cleanliness is far from what it should be. The very manner of our living may invite the presence of germs, or make us more susceptive to their ravages.

A continued aggressiveness of epidemics may at times be due to the sociological relationship of the people, even though sanitary methods are practiced. The habits of living of certain people are generally such as will promote the spread of contagious diseases, that may obtain a foothold among them. Congregations of crowds assembled at one place or another introduce an opportunity for epidemic diseases to spread. Such spreading of the causative agents of respiratory or sputum-borne diseases may be by the direct contact with the droplets of saliva, spread by kissing or by inspiring these infective agents, expelled by diseased individuals (mild or severe cases), and convalescents and by so-called "carriers," during the acts of sneezing, coughing, loud talking or spitting and expectorating. It is, however, more often spread by indirect contact in crowded quarters through the hands first coming in contact with inanimate objects (contaminated with fresh contagious material) and then brought to the individual's mouth or nostrils.

Let us briefly review the many other ways by which the infectious sputum or droplets may be transferred from the infected to the noninfected.

Many of the organisms that are the cause of sputum-borne epidemics die quickly in an atmosphere devoid of moisture. A few of them withstand drying very well, and have been found many times in the dust from rooms where cases of respiratory diseases are found. It is therefore possible that some of these diseases may be transmitted by infected dust, although the probability is, that the greater disadvantage of the dust lies in the fact, that the dust particles may irritate the membranes of the nose and throat, and thus give the organisms already there a more fertile field in which to exert their activities.

THE ARROWS OF DISEASE

The common drinking cup, utensil, or towel is rarely met with in public places. But has it been abolished in the semi-public places, or in the home? There are far too many offices, working establishments and homes still employing the common drinking cup, and even a towel for general use. There are many soda fountains and street vendors using the imperfectly cleansed glass. And may I just point out a few other transfers by direct contact, that we meet in everyday routine:

Many still practice the disagreeable habit of licking stamps, envelops, etc., which may have been handled by others, whose hands may have been unclean. Offices and especially all post offices should be supplied with the wet roller or similar contrivances (even if only a wet sponge) employed to moisten strip paper, so that individuals will not have to use their mouths for licking purposes. There are also far too many individuals, who moisten their hands or fingers with their saliva to enable them to grasp tickets, paper money, and other objects with more ease before passing them on to others.

In feeding children, there are many adults who still blow their breath on the child's food to cool it, or even taste it, and feed the child with the same portion they had to their own mouth. The adult may be a carrier of disease, without knowing it.

The breast-fed child is not only in close contact with the secretions of the nose and throat of the mother, who must be careful, but I believe very frequently, the child fondles and takes the breast after the nipples may have become contaminated from the mother's clothing or hands. Mothers are told to wash the nipples with boric acid solution before each feeding, but is this done by all at every feeding?

In this connection, mention may be made of the too frequent use of dirty pacifiers and unclean nipples for bottle-fed children.

Then we have the friendly transfer of pocket handkerchiefs, or the adult employing his own kerchief on the child's mouth or nostrils.

The placing in their mouths of objects, which may have been used by others, is of frequent occurrence. There are many familiar practices of school children and playmates, affording opportunities in the direct passage of an infective agent, as in the use of candy, chewing gum, moistened pencils, toys, kissing, etc. Children possessing the habit of keeping their fingers in their mouths should be corrected and rid of such practice. Kerchiefs should be changed frequently, especially after much secretion has accumulated on them.

The help question in the home is a serious problem today. Many housewives are compelled to obtain help, who possess personal habits that are far from clean. Many of them sleep out, usually in congested quarters with friends or relatives. It is really difficult to avoid bringing infections into the homes, when this condition prevails. The least the housewife can do is to advise (and see to it that it is carried out) that assistants of such type do not fondle and caress the children, as so many of them are prone to do.

In the home, especially, where a diseased individual may be found, one may find that the utensils and tableware, which may not have been scalded or cleaned properly, may help in spreading the infective agent from individual to individual.

Telephone mouthpieces harbor moistened droplets of sputum, saliva, etc. Individuals who have a habit of placing their lips directly within the mouthpiece are apt to have an infective agent transferred to their own mouths. The use of white celluloid, glass or similar guards, which should be wiped or cleaned frequently, is to be advocated.

With the wide use of the lipstick, a warning may be sounded against the friendly interchange and application of such cosmetics belonging to others.

The close contact, that inevitably occurs in sleeping quarters or bedroom, makes it necessary to guard and clean these quarters with greater care. The patient's or carrier's environment is almost always infected by droplets expelled during talking, sneezing, spitting or coughing. Whether or not bedding and clothing play an important role in the transmission of the infective agent, deposited thereon, is not always possible to determine. It is highly improbable that the droplets will actually reach the mouths or nostrils of those in the room, unless they get on the hands during the handling of the material; or if an individual should sleep on or wear such contaminated material. We may reason, however, that after the drying of the sa-

liva or secretions, the infective agent may be stirred about in the room; and if it is a strong resistant organism, the dust may become infective. Whether or not such reasoning is correct or incorrect, it is obvious, however, that clothing, bedding and all other personal belongings will not be injured but surely benefited by frequent exposures to fresh air and especially sunlight.

It is well-established that contaminated milk may assist in the spread of diphtheria, scarlet fever, epidemic streptococcus or septic sore throat and other respiratory diseases. There is the same possibility that other foodstuffs may become contaminated with such infective agents. It is therefore advisable to practice at all times the thorough washing of fruits and all other foodstuffs, which can be conveniently washed. Wherever possible such fruits should be peeled. Other foodstuffs can be cooked; and milk should be pasteurized, unless one is assured of the cleanliness surrounding the collection of such milk.

EVEN HECTOR THE PUP MAY BE GUILTY

Various domestic pets have been regarded by the layman as being able to communicate respiratory infections. Thorough experimentation covering but a few diseases has revealed, that there is no ground for believing that these pets can serve as carriers of such infective agents. It would be best, however, to avoid fondling these pets, until more data will become available.

Concerning the host, there are many factors which may lower his general resistance, so that harmful micro-organisms are enabled to exert more readily their destructive powers. These, frequently referred to as the predisposing causes, depress the individual's vitality, producing a diminished resistance. They may include one or more of the following:

Improper or inadequate ventilation, dusty or too dry atmosphere, sudden changes of temperature, exposure to wet and cold, insufficient or unsuitable food; overwork, fatigue and worry, insufficient sleep and rest, physiological defects in the respiratory tract.

Many of the foregoing causes which diminish resistance to infection require the application of common sense, which is just as important in sanitation as the principles of hygiene. In addition, life in this country today requires a greater knowledge of mental hygiene, a branch of personal hygiene which is being sadly neglected.

The mere mentioning of most of the foregoing predisposing causes is in itself sufficient. I think you can readily see how they

may act in lowering the resistance of an individual. But there are some fads in vogue, that should not be practiced, and certain principles involved with which you should be familiar. I will therefore ask that you kindly bear with me for a while, so that I may bring these to your attention.

Why are sputum-borne diseases most common and usually only epidemic during cold weather? The seasonal prevalence of these diseases may be partially explained by the fact, that there is an increase of nasal and oral discharges resulting from the cold weather. The hand touches the nose and mouth more often in the winter, than during the warm weather. Frequent hand contamination, and mouth to hand and hand to mouth transmission assist greatly in doing the rest. I personally feel that the use of the gauze mask by many of us during that great disastrous Pandemic of so-called "Influenza" eight years ago gives weight to the theory of the role of transmission, played by the hands. The gauze mask does not exclude airborne organisms, but it does prevent the wearer from bringing his fingers to his nose and mouth at frequent intervals. He thus finds it impossible to introduce discharges from some other person, that may be on his hands, or to soil his hands with his own excretions. Mask are therefore of some value in curbing severe epidemics.

Another important reason for the prevalence of respiratory diseases in cold weather is directly due to the fact, that children and adults, who are not warmly clad, necessarily suffer from the exposure to the cold, in the performance of their duties. It may look nice to be stylish, but, by so doing, you may be abusing your lease of life. You may think that waiting a week or more before you put on that warm clothing won't matter, but let me assure you that the influenza bacillus, the streptococcus, the pneumococcus and the other bacteria will be on hand to take advantage. They will convince you that they make no allowances. There is nothing so shameless, so arrogant, or so damaging, as the commonly observed disease-producing bacteria. Your warm clothing is part of that armor that you must employ at the proper time in your warfare against disease. Don't make a martyr of yourself in the name of custom, for truthfully you may be flirting with death.

The fad of outdoor sleeping, or having your windows wide open at night is responsible for much trouble and misunderstanding. Fresh air is good and absolutely essential. The more—the better. But must it necessarily be cold air, or do we have to be cold when receiv-

ing our supply? The air may be cool, but it should not be cold. Sleep out-of-doors if you want to—but keep warm. Open your windows as wide as you want, but use a muslin screen or some ventilating device so as to check the cold stream of air and wind. See that you don't have to shiver, and that you quickly protect yourself, when getting out of bed in a cold room. Some arrangement should be used to see that the covers are kept intact over the bodies of children when sleeping in cool rooms.

In the school room or office or plant, don't expose yourself suddenly to the cold air by opening your windows, unless you are warmly clad.

I think teachers especially in elementary schools should take more precautions than some of them do, when raising the windows suddenly during exercise, that they may be conducting during daily routine. And they should not allow the youngsters out during recess, unless they have their overcoats or are warmly clad. The important fact to keep in mind is that the body temperature must be maintained at a constant equilibrium, and unless the body heat is conserved, we may anticipate trouble. During the summer months, this can easily be done by removing the clothing. During the cold months, the only rational way is to supply sufficient or suitable covering. By all means keep warm. I firmly believe that exposure to cold is one of the greatest factors predisposing to respiratory diseases.

In this connection, mention may be made of an undesirable practice in vogue in some of the school districts. In those communities where the elementary pupils are in attendance two sessions, a half-day holiday was generally allowed on the days when the weather was bad, so as to avoid undue exposure. I understand that some school boards have stopped this practice, and all children are expected to be in attendance both sessions, regardless of the weather conditions. I think that school authorities, who have approved the latter plan, should reconsider their decision, especially where it affects the primary grades (first, second and third years). Many of these young children live a long distance from the school. It may not always be convenient for an adult to take the child back to school in the afternoon session. They are usually too young to guard themselves against the rain, even with an umbrella and other means of protection. It would be much better to advise such young children to remain home, rather than expose themselves (at least on two more occasions) if they are compelled to attend two sessions.

During the cold months, various methods of heating are in general use. Some of the heating devices do considerable harm by causing excessive drying of the atmosphere in the room. The absence of the proper degree of aqueous vapor in an environment makes those present more susceptible to the cold. A room at sixty-seven degrees F. with the proper tension of aqueous vapor will be comfortable, whereas the temperature will have to be raised almost ten degrees, before one can feel comfortable if the proper degree of aqueous vapor is absent.

Perhaps more important than the discomfort is the fact, that in such an atmosphere, the respiratory passages very quickly become dry, and in turn become irritated. The mucus covering the mucous membrane acts as a mechanical protector, catching and holding foreign particles and bacteria, thus preventing their further access. The abstraction of moisture from the membranes of the nose and throat results in the mucus being replaced by dry crusts, subsequent inflammation and irritation, and the possibility of infection.

It is absolutely necessary to arrange for the presence of the proper degree of aqueous vapor. This can be done by keeping a pan of water on the stove, or water in a trough attached to each radiator, or any other similar device, which can be easily improvised in any environment.

Just as ventilation may be found defective when the supply is insufficient, a similar condition may prevail when excessive drafts are present.

I think you can all appreciate just how undue fatigue will affect an individual. Accidents not only are prone to happen to those, who have tired nerves, tired muscles and a tired brain, but they may be the direct cause of accidents to others. And in addition, they predispose to many diseases. Remember that children, students and everyone, who is preparing himself to meet the storm of life, need strength. Excessive fatigue weakens. Constant daily work just a little beyond the powers of one's endurance will leave one a ready victim to disease. Parents should see that they, and especially their children, are not overfatigued in the endeavor to move rapidly along the road of progress.

Are not some of us thrusting too much on the shoulders of our children with their school, music lessons, dance and gym classes, play, etc.? Children will rarely admit that they feel tired and exhausted. It is therefore the duty of the parent to investigate, and know when and how to direct children in their daily routine.

Our brain functions by sending its messages over long circuits, connected with various avenues in the body. All that I can say about worry and aggravation is that they short circuit these connections. I think that you can see or realize the further developments in store for one, who lets worry and aggravation stay with him over an extended period of time.

Many diseased conditions found in humans take the name of their most prominent symptom. Thus we have scarlet fever, whooping cough, infantile paralysis, sleeping sickness, etc. The common "cold" is so named, because of its supposed principal cause. But the term "cold," as it is popularly applied, is in reality a misnomer for this abnormal condition, with which we are familiar, and which causes us more annoyance, than any other single ailment. An exposure to cold is not necessarily essential to obtain the discomfort generally characteristic in common "colds."

WHAT IS A "COLD"?

One of our greatest enemies assisting the upkeep of the high incidence of respiratory diseases is this common "cold." So called "colds" are generally taken as mild infections. But "colds" frequently diagnosed or labeled under a host of different names, are very often the cause of severe epidemics; and worse than the "colds" themselves are the sequalae of these. Many of our other respiratory infections may begin like a common "cold." Other of our respiratory diseases may begin like a common "cold," and are highly contagious at this period, even before the other symptoms appear, and the actual diagnosis is made. In some instances only the early cold or catarrhal stage appears, while the other stages never develop, and the patient remains free from other symptoms during the whole course of the disease. A policy of nursing or caring for a "cold" in its early stages, with more care than is expended by most people, will be of great benefit to all in reducing both the number of respiratory infections, as well as the danger of epidemics.

I think I will be conservative in my estimate if I say, that in this country alone there are at least 250 million days lost a year due to sickness caused by "colds." At a minimum rate of four dollars per day, the economic loss amounts to at least a billion dollars each year. It may be that the actual figure is several times this amount. The economic importance of being healthy, avoiding colds and caring for them in their early stages, becomes more important, when we think of this loss.

The common contagious "cold" is caused by one or a group of two or more organisms. These may normally be present in the mucous membranes of the nose and throat. They are prevented from exerting their noxious influence or from multiplying and reproducing rapidly, by the protective properties of the mucus which is present. As soon as this protective barrier is broken down, the organisms exert their effect by multiplying and attacking the mucous membranes. Finally the poisons produced by these organisms, after reaching an appreciable quantity, enter the blood stream and the production of headache, pain all over (especially in the joints), general malaise and the other characteristic symptoms are the result.

Exposure to drafts, sudden changes of temperature, chilling of the body, etc., do not and will not produce "colds." But they, as the predisposing factors, help to destroy nature's protective barrier. The specific causative agent already there then produces the "cold."

In some cases a second process may be explained, by which contagious "colds" may be produced. Here the predisposing factors play little or no role. The entrance of large numbers of exceptionally virulent bacteria into the respiratory tract of an individual will produce a spontaneous "cold," due to the fact that the average individual is generally unprepared to resist large numbers of highly virulent strains of organisms, coming directly from without, and usually from one suffering from a "cold."

The exact cause of some of the air and sputum-borne diseases are not known as yet. This is especially true of smallpox, mumps, chickenpox and German measles. In spite of this lack of knowledge, the many facts, characteristic of the respiratory diseases (the causes of which are known), are also of value for those respiratory infections in which the exact causes are still unknown. As mentioned, these are, that they occur endemically and epidemically. The different cases as well as the various epidemics of these diseases vary in their severity, in their prevalence, duration, contagiousness, etc. At times, they may be difficult to diagnose. Although few cases may be found constantly in certain localities throughout the year, the greater number of them prevail during the cold season. Many of these infections begin as a cold, or may apparently act mildly as far as symptoms in general are concerned. But they are contagious and the mere presence of an affected one who is careless is sufficient to cause others to become ill. It is this apparent mildness, coupled with other minor factors, which make it difficult to suppress or prevent

the spread of them. The affected person must exercise great precaution, which others, who are in danger of contracting the disease, cannot do for him. It is due to this, that health and disease are not to be regarded merely as the private concern of an individual or family, but conditions in which the entire community, and even the nation are interested. All of these respiratory infections are spread by the discharges from the nose, throat and mouth. All are crowd diseases, in the sense, that their spread is favored by the crowding of human beings, either in the home, at work or in public places. To control the spread of these diseases, they should be discovered early. It is therefore the duty of the affected one to present himself before his doctor, as soon as he feels some discomfort and not wait until he feels worse. All of these respiratory infections are liable to complications of one kind or another, and it is these and their sequalae, which add materially to the high fatalities that prevail.

I have discussed the many predisposing factors, the characteristics of bacteria, and given you a number of general measures, which may be taken to prevent sputum-borne diseases. There are, however, a number of specific measures which should be brought to your attention.

The sick, all cases including mild and convalescent cases, as well as carriers should be segregated. This is known as isolation. Quarantine refers to the detention of all persons (even those apparently in good health), who may have been exposed to a communicable infection. The length of time one should be quarantined is equivalent to the period of incubation of the disease. This incubation period, which varies for the different diseases, is the length of time that elapses between the exposure to a disease and the beginning of symptoms.

The two terms isolation and quarantine are often used interchangeably.

"IN QUARANTINE"

Isolation and quarantine have been and still are unpopular. The question has always been asked by the layman whether the considerable amount of inconvenience caused by such treatment is really worth while. The answer is irrevocably, yes. Isolation and quarantine are most valuable measures in reducing the prevalence of communicable diseases. But the decision as to when and how to isolate, or whether the other members of a household should be placed in quarantine, must be decided for each disease and even each case sepa-

rately. It is also important to see that the attending factors are considered before arriving at a decision. If our environments ever reach that state, wherein they will be found to be in the best sanitary condition, and humans will observe the laws of hygiene in accordance with the teachings of modern science, there will be no need for quarantine, and only the sick will be isolated voluntarily.

The darky, who referred to his child, ill with measles, as being "in guarantee," had a fair idea of the nature of quarantine anyway, for such isolation does "guarantee" some safeguard over the welfare of others.

It is to be hoped that some better method of protection from these epidemics will be found to replace the somewhat ineffectual one of unpopular quarantines and regulations which inconvenience travel. But, remember, that isolation of the diseased one or carrier, harboring organisms that are the cause of communicable diseases, is here to stay, and will always remain one of the chief measures for the control of communicable diseases. Every case isolated is a focus of infection placed under control, and is to be so treated, in order to prevent the spread of this communicable disease to others. Isolate the diseased one, as soon as the early symptoms appear, even, if it is only a "cold." If you will remember this fact, and cooperate with the public health worker in carrying it out, you will assist in preventing the spread of air and sputum-borne epidemics, and perhaps the future may find itself completely rid of these disasters. It is to be regetted, that many laymen do not cooperate as they should. There are many cases of communicable diseases, which are not placed under proper control. Some bring pressure to bear, so that the attending diagnostician does not report the case. There are other laymen, who because of previous contact are capable of detecting certain cases of measles, chickenpox, etc., and not wanting to be quarantined, they treat the cases themselves to the best of their ability. It is a frequent occurrence therefore to find, that many such cases leave their beds before the proper time. And of greater harm to the community is the fact that these convalescent ones are allowed to mingle with everyone (children are sent to school, adults go to work), and the result is that the nucleus for the development of an epidemic is here. Mothers, who really know better, send their children, convalescing from communicable diseases, too early to school, so as not to be annoyed by them around the home. But, if they would stop to think how they would feel, if they learned that their healthy child

was to be found in such an environment, created by some other child's mother, I think the health worker would not have to appeal to them again for cooperation.

EFFICIENT DISINFECTION OF SICKROOMS

A question which the layman always wants to know is how to disinfect the room, in which the patient has been isolated. Gaseous fumigation, frequently termed terminal fumigation, is not practiced to any great extent today in preventing the spread of air and sputum-borne diseases. After the patient is released from isolation, a general cleaning of the room should be practiced. All woodwork, floors, and everything (including the bed), that will not be injured by water should be washed with hot water containing 1 or 2 per cent. of an efficient coal tar disinfectant. All kerchiefs, linens and fabrics, that have been exposed, should be disinfected in a similar solution or boiled and laundered. Other material including mattressess, etc., which can not be washed or laundered, should be removed and exposed to the air and sunlight. The room itself should also be aerated and if possible, receive the beneficial effects of the sun for a few days. After such treatment, there will be no danger if healthy individuals are to occupy this room.

There is one disease, which is included in this list under discussion, that parents are apt to take little pains to avoid. They even sometimes expose their children to cases of measles, which is the most highly communicable of all acute infections, due to the fact that it is most contagious, even before the eruption appears. It is a mistaken belief, that every child must sooner or later contract this disease. In the present state of our knowledge, we know that this is not true. Measles, once regarded with humorous scorn, is to be feared far more than the other dreaded communicable diseases. Furthermore, most of the complications and fatalities in measles occur during the first six years of life, with the result that measles is today regarded as a deadly disease, possessing a great destructive effect on child life. If we can even delay the onset of this disease beyond the age of six, it is possible that there may be a marked decrease in the mortality and complications that occur.

The possibility of employing chlorine and similar gases in any protective campaign, aiming at the eliminating of air and sputum-borne diseases cannot be considered at this time, as they have not yet proved to be of any marked value.

Other than the application of general sanitary measures, and

guarding against many of the predisposing causes, the prevention and control of some of these air and sputum-borne diseases is best carried out or aided by artificial immunization.

The prevention and control of smallpox depends primarily upon the artificial immunity or resistance, created by vaccination with modified smallpox virus. Remember that one vaccination against smallpox will afford only a temporary protection, which will wear off after seven to ten years. Two vaccinations of individuals (preferably at the age of one and twelve), living in countries where smallpox is not common, are usually sufficient to protect them for life against this dreaded disease. If there is particular danger of exposure to smallpox, as there would be by those visiting the Far East, it is usually advisable to have the vaccination repeated, even at five-year intervals, as is practiced in Japan.

Diphtheria may become not only one of the preventable, but also an uncommon disease in the very future, if the layman will cooperate with the public health worker by seeing that all children, who are not naturally immune to diphtheria, receive the artificial immunizing treatment against this disease.

THE NEWER DEFENSIVE REMEDIES

Diphtheria, until recently an unconquered scourge of children, has been and is gradually being subdued and eliminated by means of its own poison, which is constantly being produced and thrown forth by the Diphtheria Bacillus. This poison, injected between the layers of the skin, tells whether or not one is susceptible to the disease, giving us what is known as the Schick Test. Injected deeper and in larger doses under the layers of the skin, this same poison causes the body to build up a resistance against it. This is the principle of the three injections of the Toxin-Antitoxin mixture. It is, however, always advisable to follow up these injections by means of a Schick Test, so as to be assured that the patient has developed a resistance, and thus possesses the power of neutralizing the attack of any subsequent natural exposure to diphtheria. In most cases, the Schick Test will be negative after one series of injections, but there are some subjects who require more than one series of injections to protect them completely against further attack. It is to rule out such cases, that it is always best to repeat the Schick Test after the series of injections has been completed.

I have personally obtained positive cultures in children, who displayed all clinical signs of diphtheria, even though one series of

Toxin-Antitoxin mixture had been administered. In these cases, I mention, the Schick Test was not repeated after the injections.

Observations thus far have demonstrated, that by the injection of the T. A. (Toxin-Antitoxin) mixture, a child probably will be protected for life against diphtheria.

Artificial immunization against smallpox and diphtheria have definitely proved of value in affording protection. It is to be recommended as the only logical action to take rather, than to blindly trust to luck.

Blood and blood serum from convalescent cases of scarlet fever and measles have been used with some degree of success in the treatment of patients, ill with scarlet fever and measles. Encouraging results have also been obtained in the use of such blood or blood serum in affording a means of prevention against these diseases.

The causative agents of scarlet fever and measles remained undiscovered for years. In 1924, Drs. G. F. and Gladys H. Dick, of Chicago, claimed that certain streptococci were the cause of scarlet fever. With the poisons (known as Toxins), secreted by these streptococci as a basis, they developed an anti-scarlet fever serum, which, being of specific value for the toxins, is known as (scarlet fever or streptococci) antitoxin. The toxins from these streptococci are employed in the so-called Dick Test, to determine whether one is or is not immune to scarlet fever. The test is performed in the same way as the Schick Test. The antitoxin is recommended for the prevention and the curative treatment of scarlet fever.

The year following, French scientists, working under Prof. Leon Bernard, and Drs. Ferry and Fisher in this country announced the discovery of a streptococcus, as the cause of measles. It appears that streptococci in their various forms and strains are accountable for many diseases, including septic sore throat, erysipelas, etc., in addition to being able to induce general blood poisoning. An anti-measles serum was recently introduced to make possible the prevention and control of measles.

Experience in the use of both anti-scarlet and anti-measles sera or antitoxins have demonstrated the value of these preparations in the treatment of the respective diseases, especially if they are employed immediately after a diagnosis is made. Their use in the production of an immunity or resistance against scarlet fever and measles has not extended over a sufficiently long period of time for an estimate of their exact value as agents which will afford a protection for

many years. Until more data over a longer period of time is forthcoming, it will be impossible to determine the practical value of these preparations, and I think it unwise to advocate their UNIVERSAL USE as protective agents, as in the case of modified smallpox virus for smallpox and the T. A. mixture for diphtheria. Since experimental and clinical observation have demonstrated that these antitoxins confer protection lasting from a few weeks to two months, these preparations offer a valuable safeguard for immediate use by children and in cases who may have been exposed to sufferers of these diseases.

Practical considerations must be taken into account when we proceed to advocate universal vaccination. It would hardly appear desirable to advise universal vaccination against diseases which do not occur in sufficiently large numbers, as in the case of meningitis, septic sore throat, etc. Such procedure is only advocated to introduce a protection against those communicable diseases, that are commonly found and which nearly all of us either as children or adults may easily contract.

Vaccines have been prepared against some of the other sputum-borne infections, that may become epidemic. Such preparations are available for whooping cough, influenza, colds and meningitis. It is difficult to obtain information as to their efficacy. In all of these cases, it does not appear probable that the use of vaccines will afford a protection against the respective diseases for any great length of time. There are so many other practical difficulties in the way of efficient vaccination against colds and influenza, that it is unwise to attempt to make such measure the basis of a universal protective campaign. It is best to allow each case to be treated individually by the attending diagnostician, who must consider all facts in the case, and perhaps resort to the use of vaccines, when other measures do not completely give the desired results.

May I impress upon you the fact, that a greater importance is to be placed upon the general methods, which were considered for the reduction of all air and sputum-borne diseases. Specific measures, that will materially reduce the incidence of many of these infections, are only to be advocated for universal use, after extended experience has proved their value.

In conclusion, may I say that I hope you have been impressed with the necessity of training yourself to conquer disease, especially those epidemic in character. It should be your duty to cooperate in public health work, not only by training yourself, but by exercising

such influence, as may be possible, on those within your immediate environment, that they too will cooperate. Bring legitimate influence to bear on all agencies, that are concerned in any way with the educational system of your community, from the elementary school to the college, or in the distribution of knowledge, whether it be the newspaper, magazine, and other publications or the visual agencies of the motion picture screen, pictorial reviews, or over the speakers table at the lodge or the various beneficial organizations.

The mere fact that you believe in the principles behind public health movements is not sufficient excuse for you to sit back with a proud satisfied air, and with a feeling, that you have enrolled, and that's that. Do not be a joiner, but a doer. Be a working member as well as a signing member of the desirable movements in your community. Do not merely enlist, but march forward with those ideals, with which you are delighted to identify yourself. By so doing, you will advance the physical, mental and moral welfare of our nation.

I also wish to say that I do not want to leave you with the impression, that I am making scientific efficiency something supernatural, or that health and sanitary regulations are to be uppermost and constantly in your mind. All that I ask is that these correlated facts be incorporated merely as one of the important articles of your creed, that you have framed to guide you through life's journey. You will thus be able to function better and live longer. And may I say that you will benefit even more in reaching this goal, if you become imbued, not only with the facts, but with the spirit of science, and the code of the Fifth Estate, which directs its men to give service unselfishly (to humanity).

MY LADY NICOTINE

By Ivor Griffith, P. D., Ph. M.

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IT MAY not be particularly to the credit of the speaker of this evening to have elected for the topic of his discourse in this series of Popular Science Lectures, a subject so distinctly controversial as this Tale of Tobacco. Yet there is not in this day the vicious antagonism to the sovereign weed that existed and exhibited itself some few generations ago. Poets and preachers, kings and cardinals, joined in the word-slinging campaign, so vigorously waged, to suppress the then-called "filthy tobacco evil." Awe-inspiring were the tirades hurled at it; dictionaries were plundered to provide poets and preachers with punishing puns and even a king of Merrie England lent his wit, or borrowed his wit, to write an awful essay entitled "A Counterblaste Against Tobacco."

Ivor Griffith, P. D., Ph. M.

The discovery of tobacco was practically coincident with the discovery of America. Columbus and Company, as truthful histories record, brought back from their newly-found world much more than just news of their trip. As some unkind historian has put it—"Tobacco was not the only disease that the Pinta and the Nina and the Santa Maria brought back."

When those hardy explorers landed in the New World one of the sights that most bewitched them was to see the natives of the Indies "roll their own" and belch their smoke from lips and nostrils. This smoking business rather appealed to the white man, and it was not long before he exchanged habits with Lo, the poor Indian. Exchanging bad habits works inversely like exchanging ideas. When two parties barter ideas, both parties benefit, but after Lo and the Spaniard had exchanged their bad habits, both had gained in iniquity—each had both the firewater and the tobacco habit.

So to Europe came the weed. Spain, of course, was its first love and decades before England knew aught of its existence, the courts of Phillip and Isabella reeked with the blue haze of tobacco combustion.

In 1564, when good Queen Bess ruled England, some of her polite freebooters visited the new Continent, and on their return introduced the pipe, if not to Elizabeth, at least to her sturdy subjects. Admiral John 'Awkins, Sir Walter Raleigh and Francis Drake all vie for the credit of bringing the weed to England. Of the three, Walter apparently had the best publicity manager—for what schoolboy has not been thrilled by the story of the gallantry that cost him, so History tells, a perfectly gorgeous coat. But who would not have done precisely the same thing under the same circumstances—so cheaply to earn a Monarch's gratitude. Chances are that for a shilling or two the coat came back from the dry-cleaning shop—looking "as good as new."

WHEN GOOD QUEEN BESS RULED ENGLAND

Then there is that other story of Walter's first smoke in public, and how his Irish servant, observing smoke creep from his master's nostrils, thought him on fire and drenched him with a generous piece of the River Shannon. On his estate at Youghal in Ireland, Raleigh grew his own tobacco, planted from seed that came from Virginia.

But when James the I ascended the throne vacated by Elizabeth—came a new turn on things. James hated Raleigh, who had been Lady Nicotine's and Elizabeth's petted favorite—and James had a perfect right to show aversion, for his mother, Queen of the Scots, had perished at Elizabeth's orders.

Tobacco, too, was a Protestant weed and James never loved Protestants. So it was not long after he donned the ermine robe, this comical king showed his teeth to tobacco. At his request the Prohibition of Tobacco was formally discussed in the dignified House of Commons—and its proponents were so eloquent, and the business of displeasing the King more eloquent still, that the Sovereign Herb became a weed indeed in England. Its use was forbidden and dire penalties imposed on Cavaliers who might be found carrying a pouch of Virginia shag upon their hips. Yet strangely enough, so a commentator of the day records, pipes were still sold in the shops, and tobacco pouches, and pipe cleaners.

Tobacco with strange labels, immature or adulterated with chestnut leaves and Irish cabbage, was clandestinely sold, and at exorbitant

prices, and men who engaged in this nefarious trade were called bootleggers,† because it was in their high leather leggings that their stock in trade was carried.

Yet there was, so we are told, a legitimate use for the weed in medicine—and recognizing this need, the law permitted its purchase in certain restricted quantities, providing, of course, that dealers in medicines and practicing physicians were duly and properly licensed.

It was even whispered about that members of Parliament frequently left their country and crossed the channel to France—on official business, 'twas said, yet only to smoke in safety.† Among the rich, surreptitious smoking grew into a great fashion, and it is said that the habit was more and more indulged in as the years went on.

Discontent and disregard of law infected everybody in the land. The far-famed English liberty bunioned at the ankles for weight of ridiculous chains. But why continue so involved a story—sufficient has been told to relate what terrible days were upon Merrie England when whims of Kings—half-witted Kings at that—dictated the laws of the land. How wiser has our world grown—how much more tolerant! (?)

Today the tobacco habit has become so general that one seldom meets with any formidable criticism of it. What potential dangers may be in its over-exercise have been too readily forgotten. It is not in the fashion today to be antagonistic to tobacco.

And fashion is funny anyhow. There is a fashion to every phase of life. Indeed one might say that Evolution is simply fashion. Times change, people change, habits change, circumstances change, and here perhaps is where Life's beauty resides.

The pulse of Life vibrates with change of habits, and of actions. Possibly man's foolishness is as necessary to his comfort as is his great wisdom. He steps in error and falls to meet his penalty—he achieves and is thrilled with satisfaction—failure and success—experiment and proven practice alternate in dizzy cycles.

†Philologists please do not copy. This information can not be authenticated.

†History repeats itself. Quite recently the mayor of a large American city, shortly after receiving a report on "Deaths from Poison Liquor," showed his reaction to it by spending his vacation "crossing the channel" to Havana, which is in Cuba.

And it is not strange that History so often warms up its cooked goose and serves it to several separate ages—for man himself is but one of the changing fashions in the infinite scheme of creation.

HISTORY WARMS UP THE COOKED GOOSE

So it may be that the day will again repeat itself when Tobacco, too, will be taboo in every circle of society. Today, however, my Lady Nicotine enjoys an unusual popularity. Who slanders the lady commands no audience.

The invention of the lucifer or match also helped to light the way for my Lady's progress—for people smoked more when lighting the pipe was made easier for them. I doubt very much if many of us would smoke did we have to light our cigars with a tinder box or flint. It is bad enough when we have to be bothered with these new-fangled Christmas present contraptions, devised to replace matches, which light only when the spirit moves them—and half the time the spirit has evaporated.

So we say that tobacco went marching on and today, especially to one who acknowledges a daily delight at the shrine of the Lady of Sinuous Smoke, no criticism carries much weight. In his famous Ode to Tobacco, Calverley the English poet, most clearly sings the song of the confirmed tobacco lover:

I have a liking old
For thee, though manifold
Stories, I know are told
Not to thy credit.
How one (or two at most)
Drops made a cat a ghost,
Still why deny thy use
Thoughtfully taken.
We're not as tabbies are—
Smith, take a fresh cigar;
Jones, the tobacco jar;
Here's to thee Bacon!!

But I cannot refrain from referring at greater length to

The gentleman called King James
In quilted doublet and great trunk breeches,
Who held in abhorrence tobacco and witches.

His "Counterblaste to Tobacco" was a giddy piece of literature—and yet so quaintly written and so sensibly in spots, that one wonders what manner of man was this James, who could be so wise on paper and so silly a fool in practice.

This work first appeared anonymously in 1605, but when it seemed to have gained favor with the feminine and the effeminate portion of England's people, it was acknowledged as the handiwork of his Majesty the King. When the King so boldly opposed this "fierce vice" quite naturally the worms and parasites that infested his Court likewise protested with horror the wave of smoke-mania that rolled over England.

"Smoke," states the royal *counterblaste,* "becomes a kitchen far better than a dining chamber; and yet it makes a kitchen* ofttimes in the inward parts of men, soyling and infecting with an unctuous and oyley kind of soote, as hath been found in some great tobacco takers, opened after death." James, you see, clinched his arguments as some of our great surgeons do, who demonstrate the success of an intimate carving technique, during the post-mortem that follows the successful operation. But that is another story.

Listen to the logical acumen of this: "Why," he asks, "since we imitate the beastly and slavish Indians in taking tobacco, do we not imitate them in walking about with no clothes save a bunch of foolish feathers?" Quite an odd, even if logical argument, to come from one who day and night wore a quilted dagger-proof vest. Then comes the famous climax.

"A Custom Loathsome to the Eye—Hateful to the Nose, Harmful to the Brains, Dangerous to the Lunges, and in the black stinking fume thereof nearest the Horrible Stygian Smoke of the Pit that is Ranke and Bottomless."

But these effusions of the "wisest fool in Christendom" availed but little, and my Lady Nicotine continued to extend her domain to every corner of England. Some say that it was King James' jealousy of Sir Walter Raleigh that embittered him so to the weed which Sir Walter first brought to England. History further records that when the King saw the trend of the times and the onward march of Tobacco, he very artfully introduced the business of inordinately taxing the weed and so filled his coffers with riches. He was consistent, though, in that he never fell into the habit, at least not publicly.

His Prohibition of Tobacco lasted only a short while, but his idea of taxation has lasted ever since. The bit of blue stamp on my cigar box is a relic of a plan of money-grabbing fostered by that idiotic English monarch. Exit King James.

*To what kind of kitchens was King James accustomed?

But opposition to tobacco did not die with James—for the world, even then, was much greater than England. In every country wherein my Lady entered she encountered rabid opposition.

PERSIA PROHIBITS TOBACCO

In Persia, Abbas I, of hideous memory, ruled that for those who dared to smoke, their lips would be promptly ripped off—"like bark from the birch tree"—and the noses of any who ventured to snuff would likewise be bobbed. Strange to relate old Abbas himself at last succumbed to the weed—and bobbed noses were no longer the vogue.

The Turks, too, suffered like indignities till one of their seventeenth century rulers, probably reading a high-powered ad in the Turkish *Saturday Evening Post*—turned to the lure of the brand "that satisfies." Anyway, opposition to Tobacco ceased in Turkey about that time and the unspeakable Turk turned to a new kind of atrocity. These atrocities are now put up in packages.

In Russia, too, the use of tobacco was banned—the first offense was penalized by a nasal operation without ether—if guilty of second offense death only could wipe out the crime. The Czar Federowitz encouraged the cultivation of whiskers as an additional fire hazard against the progress of the fiery stogie. But nothing hindered the world-wide ambitions of the herb of the Indies—insuperable obstacles only seemed to spur it on.

Profiting by the experience of Persia and Russia and the land of King James—America, the native land of Lady Nicotine (where happy Indians, long before the white man's coming, had drawn contentment from a common calumet), thwarted my Lady's progress not with force of punishment and penalty, but rather by force of argument and propaganda. So late as 1883—there was a voluminous literature dedicated to the anti-tobacco question, and to read these products of mental fermentation, provides in this enlightened day, not inspiration, not admiration, but a fine and salubrious amusement.

I have before me as I write, a volume entitled "Anti-Tobacco," written by Abiel Abbott Livermore, and others. Abiel and the others have long since changed to silent, inorganic dust, but as I read through their doleful indictments, I wonder just how long these venerable Puritans from Boston-town would survive one trip around their beloved Commons on a balmy spring day in this year of our Lord 1927.

There they go—let us follow their spirit shadows. Everywhere gay signboards and posters scream at them with the urge of the num-

berless brands of tobaccos and smokes. Blood-red store fronts with the sign of the shield, pour out their satisfied, couponed votaries. Lady Nicotine rules everywhere. Our Puritan friends lower their translucent eyes in shame, but even the sidewalks suggest "Ask Dad—He Knows"—and empty cartons and unfinished symphonies in cincos cause them to lift their compassionate gaze to the Heavens for comfort. And behold even there, hanging to the brim of a flying cloud, is the smoky message of an artful birdman:

"Chesterfields—They Satisfy."

But the finishing touch that sends the Puritanical ectoplasms back to, where I hope, is no smoke at all—is the personification of my Lady Nicotine herself—as she cuts across the Boston Common—knee deep in silken stockings, high-heeled in artful slippers, her raven locks close-trimmed—her face lifted and held secure in place with putty paste and pigments. Out of a crimson crevice crosswise on her face, protrudes a dainty and sweet—Caporal.

Obedient rings of perfumed smoke herald the haughty lady—this 1927 edition of my Lady Nicotine—the flapper herself—and you can hear the swish of Abiel and the others as their spirits rush on to their smokeless haunts, to be guarded forever by oodles of needles, through whose constricted eye no *Camel* can hope to pass.

I quote—now that the spirits have left—from Abiel's acetic essay:

> "The use of tobacco is an indignity to the Female Sex. I shall not discuss here the question whether a man can be a gentleman, and smoke or chew. Suffice it to say that every person conversant in society knows full well that the customs of a truly polite and refined community are often set at defiance; that the offensive spittoon (refined Bostonese for *cuspidor*) corrupts the air of the sitting room and parlor; that, worse still, the floors of churches, court houses, cars and steamers reek with the filthy expectorations of the chewer and smoker; that the sweet air of heaven, in which we all have a common right and interest, is blighted by the trail of smoke that the reeking pipe emits.
>
> "It is true that some women of old smoked their pipes and some still use the more dangerous cigarette; but as a general custom refined women are exempt from the evil. They detest and loathe it in their fathers, husbands and sons. How can pure and noble women endure the presence of men such as we meet daily on the streets whose lips are varnished over by the slimy juice, whose breath is a wicked stench, and whose clothing exhales the stale effluvia of countless dead cigars?"

And that is not a half of what Abiel uttered. I have long suspected that Abiel must have swallowed his first and only cigar butt—such bitterness and mental nausea could have been in no otherwise engendered.—Exit Abiel.

Enter now our Lady Nicotine. Her name she inherits from Jean Nicot, French Ambassador at Lisbon, who in 1560 sent some tobacco to Catherine di Medici as a cure for headache. Catherine was much pleased with it, but soon learned that smoking it was far more pleasurable than using it as a poultice. She became a devotee, and from this incident tobacco gained its synonyms of the "Queen's Herb" and "The Sovereign Weed."

Oveido, a classmate of Columbus, published a book entitled *"La Historia General des las Indias,"* in Seville in 1526, in which he mentions pipe smoking. In this book there is a small wood cut, which is the oldest known picture of a pipe. This pipe was shaped like a Y. The smoke was inhaled by placing the two ends in the nose and the tobacco leaves in the stem. Oviedo claims this pipe was called "tabaca" from which the name tobacco probably originated. A less plausible claim for the origin of the word "tobacco" is that "Tabaco," a province in Yucatan, is the parent word.

Jean Nicot's name was perpetuated in the word nicotine and its derivative forms.

LADY NICOTINE'S FAMILY

Lady Nicotine's botanical family, the Solanaceæ, like all large families, exhibits a variety of dispositions and natures. Some are good and some bad. This great solanaceous family comprises among its members the humble spud, of Irish origin; the New York Tom-*ah*-to or the Camden Tom-*ay*-to; the vivid red pepper and the obese egg plant. The family reunion—you may observe at your leisure in a can of Campbell's soup.

Then there are the more vicious members of the family—tobacco—henbane and horsenettle, and a great many others. Strangely enough, however, not a single member of the family is totally devoid of taint—for a poison exists at some time or other in every one of the group.

Even the mild and modest potato exhibits this taint at times. The blossoms, fruit and sprouts are apt to contain active poisons. Solanine, an alkaloid in action much like the volatile nicotine or non-volatile strychnine, is a perverse potato constituent. The tomato is also said to develop a small amount of a like ingredient.

But to return to Tobacco. I should like very much to have time to speak of the cultivation and preparation of the plant before it enters into its many avenues of use. The subject is entirely too ramified, however, to permit its complete survey.

Every phase of its handling must be expertly done if the final product is to be worthy. From the choice of seedlings—it is a perennial plant but yet annually planted from seed—and the selection of suitable soil and exposure—to the harvesting of the crop—and the special methods of sweating and preparing the leaf—then to the storage—the selection of sorts, the blending of them and the final manufacture of the cigar or cigarette—every step requires intelligent attention.

The industry today is so large, and the demands of the ultimate consumer so exacting even if not exact, that those engaged in the industry are forced to use strictly efficient methods in each department of the trade.

There are a great many varieties of tobacco all belonging to the genus Nicotiana, a sub-group of the Solanaceous family. Of this genus there are dozens of species or variants, yet one, *Nicotiana Tabacum* supplies almost the entire tobacco of commerce. It is said that over a hundred varieties of this species are grown in the United States alone. Havana, East Indian and European tobacco belong to the same species. Even the famous Vuelta tobacco of West Cuba, the most expensive in all the world, is offspring of this variety.

Other important species (*Rustica* and *Persica*) produce Persian, Turkish, Syrian, Latakia and other tobaccos. Not nearly so important is specie difference, however, in the nature of the finished tobacco, as the difference brought about by curing the leaf afterwards. For instance, the particular flavor of Latakia, a Syrian tobacco (from ancient Laodicea), contrary to the general impression, is produced by curing it over the burning branches of a variety of holly, ilex.

It should be remembered that there is no essential difference in origin in cigar, pipe smoking or cigarette tobaccos. The differences are physical and in quality only. All kinds, though they vary considerably in many characteristics, may be obtained from the same species or even the same variety of the species by suitable culture and crossing and curing. Soil conditions greatly alter the character of tobacco—thus a certain variety of seed planted in Lancaster County yields an entirely different product from that yielded by the same

variety planted in Connecticut or Cuba or Collingswood. Exposure also causes variation in the growing plant.

In Connecticut and elsewhere, so that the sun may not create too much stir in the constitution of the leaf, cheesecloth parasols protect the plant and the result is a fine elastic leaf, greatly demanded by the industry. Immense plantations in Porto Rico are completely covered by cheesecloth, and from a distance appear as if covered by snow. Sand and rainspots, too, leave their mark on the plant. Especially noticeable is this on Sumatra tobacco used as a wrapper in high-grade cigars. Brown and white spots on the leaf are said to be caused by little grains of sand sticking to the leaf and burning and bleaching it by gathering the heat of the sun to the spot. The dew or raindrop, too, that acts like a lens with the sun rays, is blamed for the same thing. It used to be said that such marks on the cigar leaf wrapper indicated good breeding—in the same way that finger nail white spots were at one time considered good omens.

So certain people in the cigar trade did to their wrappers what the sand or sun had overlooked, and a totally brunette cigar would be made to disport numberless blonde spots by merely sprinkling upon it droplets of strong peroxide.

Soil nature influences leaf color to a considerable extent. American cigar trade demands a light cigar—at least a light wrapper. John Brown judges his cigar—as he does a great many other things—by the cover—and by way of paradox, it might be said—that in so judging it he misjudges it.

JOHN BROWN JUDGES (REALLY MISJUDGES) HIS CIGAR

A leaf grown in light sandy soil or very light loamy soil, with clayey subsoil, usually affords a light yellow tobacco. Heavily manured soil produces a dark heavy leaf. Yet the color is no indication of the strength of the leaf—for while a dark leaf, not necessarily strong, can not be bleached without injuring its flavor, yet a light leaf, possibly strong in constituents, may be very readily darkened by processes subsequent to growth.

It is the heart of the cigar—the filler—that regulates the potency and pungency of the smoke—the wrapper is only for ornament and for protection, and only constitutes a very small percentage of the weight of the cigar.

The harvesting is done by partly stripping the leaves from their parent stem and permitting them to wilt. They are then gathered in piles or on racks and exposed to the action of sunlight. After

the completion of "yellowing," as the drying is called, next comes the vitally important process of curing. Curing brings about intimate chemical changes in the leaves. The object of the curing is to eliminate the excess sap and water, to fix the color by completing "yellowing," or first drying to fix the flavor and aroma by preservation of the juices and to give a certain toughness and suppleness to the leaf. This is all started by the "yellowing"—and is not completed until it passes through the fermentation process carried on by the manufacturer.

TOBACCO, TOO, TAKES THE SUN-CURE

All good cigar leaf tobacco is sun-cured, while pipe smoking and chewing tobacco are usually cured by artificial heat. In the latter process the temperature ranges for the first sixteen to thirty hours from 90 to 120 degrees F.; from then for the following forty-eight hours 125 degrees is necessary to complete the curing. Dry heat and flue curing are the best. Flue curing is done with pipes around the curing houses, the pipes being fed from a furnace in an adjoining room. Most cigarette tobacco is cured in this manner. The pores of the leaves are left open by this method, thus making them more absorbent to the flavoring sauces which are added to certain kinds of tobacco. A crude method used is that of curing by open fire. This takes four or five days and gives an undesirable smoky creosotic flavor to the leaf.

Sun curing takes from six to eight weeks and sometimes from three to four months, but it retains a far better flavor and aroma, so this method is used for almost all cigar tobacco. We advisedly say *almost*—for there is a kind of cigar tobacco, so anemic and sickly, that if ever it was cured it must have suffered a serious relapse. Air curing is done in open well-ventilated sheds at a temperature of about 75 degrees F. The leaf is usually allowed to cure while attached to the stalk, although Florida curers generally prefer to strip the leaf and treat it separately. The finer classes of pipe smoking tobaccos are air-cured.

Next the leaves are made ready for market and the sorting of them is a highly specialized and finicky job. We need not enter into this diversified business, for its nomenclature with its "carrotts," its "hands," its "prizes," etc., is involved and of no special significance.

The rehandling of the tobacco from this stage on, is largely conducted by the manufacturers of tobacco products. When the leaf is first received by them, it is opened in the casing room and in-

spected. Manufacturers who make various types of product, sort out the different kinds of leaf, suitable for each line, such as wrappers, fillers, binders, cigarette leaf, plug leaf, etc. These are then sent to their separate departments. When the tobacco is received it is usually brittle and dry, and so when the bundles are opened and loosely spread out on large trucks they are first sprayed with water. After the leaves have become pliable they are sorted and blended according to the purpose in view.

The selecting and blending of tobaccos is an important task and it requires considerable experience and expert knowledge to choose leaves of different strengths and qualities and by combining them give the desired blend. It is in this step that American manufacturers have made the greatest advance during the past few years in their products. The sorted packages are then roughly fastened together and after being again sprinkled thoroughly are sent to the "sweating" room to undergo fermentation. The temperature of this room is generally kept at about 90 degrees Fahrenheit, and the bundles are allowed to stay there several weeks.

There are three objects in the fermenting of the tobacco leaf: (1) removal of acrid matters, (2) fixing of the color, and (3) the production of flavor. The change which takes place is thought to be a chemical one, in which certain organic compounds stored in the plant are split up and others formed. This change is brought about by certain oxidizing ferments—or enzymes produced by bacteria. The starch in the leaf is converted to sugar and slowly consumed. The fats and gummy substances, also nicotine, are decreased and there is formed malic, citric and oxalic acids, all of which are essential in the production of the flavor of the finished product.

Some bacteriologists claim that the changes wrought in the leaves and the production of flavor are solely the work of bacteria. This view has never been fully proved or disproved; in fact it is quite likely that the result is due to both chemical and bacterial reaction.

"WINS ITS FAVOR THROUGH ITS FLAVOR"

The leaves are next cleaned, all sand and clay being removed, and are again packed in bundles and returned to the sweating department to undergo further fermentation. Finally the leaves are sent to the stemming department where the midribs, which usually form about one-third of the entire weight, are removed.

The ribs are sold to insecticide manufacturers. Tobacco, by the way, has definite insecticidal value, which it owes to its nicotine con-

tent. Strong solutions of nicotine sulphate (40 per cent.) are used in dilution with soapy water for spraying shrubs, flowers and vegetables to rid them of insect pests. Yet strangely enough tobacco growers are greatly bothered by case-hardened insects that thrive on the tobacco crop. There is a little upholstered worm, the larvæ of hawk moths, that does considerable damage to the leaf—and a little bug called by bugologists *Dicyphus minimum,* is also a great nuisance and extremely injurious to young plants.

But to return to the "ribs" discarded by the cigar manufacturers. One wise Dutchman conceived a process of ironing the midribs flat, using great pressure, and disposing them to that element of the cigar trade known as the "rope industry."

The process of stemming splits the leaf in two and the half-leaves are arranged in piles of fifty, each pile forming a "book." The leaves are next sent to the drying room, where any remaining moisture is removed by carefully regulated hot air currents. Then they go to the "ordering" room. There the "books" are inspected for color, size, etc., and if necessary subjected to more treatment. If not they are packed in cases and stored for several months to allow for perfect and uniform blending. Then they are ready for shipment to the factory.

Leaf to be used for chewing or pipe tobacco is not put through such an elaborate process as cigar leaf. Usually such tobacco leaf is fermented in bulk and the stems are removed before the principal fermentation. After the first selection of varieties, sorting, stemming and cleaning, the leaf is dipped into large flavoring vats and after drying is subjected to steaming.

Manufacturers of chewing tobacco are very particular about this "flavoring" process. I mean that they are more particular about the flavor than about the grade of the tobacco. Listen to this formula for such a flavor, and wonder why waste tobacco at all with it, when shavings or sawdust would work equally well.

Extract of cascarilla
Extract of licorice
Extract of valerian
Extract of asarum
Tonka bean
English rum.

Here perhaps the Prohibition Enforcement outfit have missed a guess. Perhaps the venerable cut plug hides a modicum of alcohol.

After the flavoring has been done the leaves are then packed away in bulk in the sweating room and there ferment slowly with constant turning until required for use.

Cigars have changed little in the last four centuries since they were first discovered in America. At that time the natives rolled up tobacco leaves which they smoked and which the Spaniards called cigars after the Spanish word *cigarer*—to roll. Although tobacco was introduced into Spain in the cigar form, it was not until about 1790 that cigars were used generally in Europe. One of the first factories for the manufacture of cigars was established in Hamburg in 1796.

In the United States the cigar trade is far more important than that of any other tobacco product, in fact, its value is greater than that of all other tobacco products combined. The number of cigars made in this country in 1924 and on which a tax was paid was ten and a half billions. Most of these are consumed in this country along with a good many more imported from Cuba. The immensity of the industry may be judged from the following facts:

THE TOBACCO CROP

In 1912 the world's recorded crop of tobacco was 2,696,401,379 pounds and in 1913 it was 2,722,190,030. Of this amount America and Asia each produced about 350,000 tons and Europe 250,000 tons. The principal Asiatic countries which produce tobacco are China, Japan, Afghanistan, India, Persia and Asia Minor, a great deal of China's tobacco being sold as "Turkish tobacco." Oddly enough, too, most of the Turkish cigarettes are made in Egypt. The amount of tobacco leaf produced annually in the United States varies from 700 million pounds to 1000 million pounds and about one-half of this is exported as leaf, and the other half manufactured here and consumed in the United States.

To produce this immense crop we find that there are almost two million acres of rich soil under cultivation and the value of the raw crop varies from $400,000,000 to $500,000,000, which gives an average value of from twenty to twenty-five cents a pound. On April 1, 1921, there was on hand 1,818,781,268 pounds of tobacco in the United States. The peak of average price was reached in 1919. That year the farmers sold 1,440,979,349 pounds ranging from seventeen cents in Pennsylvania to sixty-five cents in Louisi-

ana. The average of these states in 1911 was nine and one-half to thirty-one cents, and in 1920 it was twenty to forty cents. The peak production was reached in 1920, with 1,508,064,000 pounds, and the states producing the largest amounts were in the following order: Kentucky, North Carolina, and Virginia. That year the estimated average yield per acre was 796 pounds, as against 894 in 1911 (the record year).

The southern states raise the bulk of the tobacco crop. A great deal is exported, while the leaf raised in Connecticut, Pennsylvania, Ohio, Wisconsin, Florida, Massachusetts and New York is generally used for the cigar trade in this country.

Although the United States surpasses all other countries in tobacco production, there are large imports of leaf for cigars and cigarettes. In 1920 imports were 82,231,396 pounds, of which 18,856,091 pounds came from Asiatic Turkey, chiefly for cigarettes. Cuba furnished 23,616,999 pounds and Porto Rico 14,728,645 pounds. The value of tobaccos exported from this country in 1920 amounted to $288,693,799 and the number of cigarettes exported that year is astonishing, being 15,833,870,000. In 1919 the cigar factories of the United States employed 160,000 workers and manufactured $773,000,000 worth of cigars alone. Of interest, too, is the fact that Philadelphia is the largest cigar manufacturing centre in the world.

The manufacture of variously sized cigars and of cigarettes are technical processes which we pass by, except perhaps to stop at points of interest. The machine has not yet totally displaced the human hands in cigar making, although such machines have long existed. Smoking is a sentimental occupation and lends itself readily to romantic by-plays. Around the hand-made cigar still hangs a great deal of romantic glamour. Yet to the initiated there is more comfort in knowing that his smoke is made by an automatic contrivance that can not possibly *spit*. For in spite of tragacanth, in spite of mechanical moisteners, the old cigarmaker prefers to seal the tip of his or her hand-made product with the natural mucilage donated by salivary glands.

Of course it is claimed that the germs so included, without additional charge, only die a certain death, by virtue of the cigar's own disinfection—personally I am more comfortable with knowing that my cigar, whether it be the prosperous panatella or a more modest cheroot, is machine-made and not a hand-made crematory for micro-

scopic carcasses. Flavoring material is not used for high grade cigars—they stand on the merit of a good blend. For inferior cigars, however, flavors similar to those used for chewing tobacco are commonly used.

Something now about cigarettes. "Coffin nails, shroud bobbins and dope-sticks"—all are ugly terms that have been conferred on this little offender. Abiel's progeny have singled out this tiniest of my Lady Nicotine's weapons—as fair game for their cheap and silly sneers. Yet it is quite true that of all forms of tobacco used, the cigarette is least harmful—except of course in excess. Even the paper used for its cover has been absurdly abused. Full of chemicals and dope—positively poisonous—so ran these foolish attacks. As a matter of fact even the cheapest kind of paper so used has in it no deleterious material, either before or after combustion. Generally it is a vegetable paper from tree fibre or from flax, although it is often called rice paper. The imported French cigarette papers still go by that name yet there is in them no more rice than there is in a cupful of jello. Saltpeter is added, so they say, to cigars and other smoking tobaccos, to make them burn more uniformly. This is a rare addition today and should be discarded entirely. Burning butts are a sufficient fire hazard anyway without any combustible assistance. But we will have something to say later of cigarettes.

THE MUCH MALIGNED CIGARETTE

Snuff: Its manufacture is based on a long and thorough fermentation, during which time most of the nicotine, acids and essential oils are removed. Some manufacturers grind the leaf up into grain before fermentation and this is called wet snuff. Others wait until the fermentation is completed before grinding and this is called dry snuff.

"To abuse snuff," says Coleridge, "is to abuse the origin of the human nose." But snuff has gone the way of most Victorian luxuries, as the parlor stereopticon and whatnots and family albums. Yet it has its devotees, and some use has to be made of dust and sweepings from cigar factories. It will be a surprise to know that twenty-one million dollars' worth of snuff was manufactured in America in 1920, most of it, however, for export elsewhere, possibly to Sweden as Swedish snuff, or to the Land of MacTavish and Fergusson as Scotch Snuff—in return for some of Scotland's courtesies.

Snuff sniffing, once a most popular pastime, is said by some to be due to return to its catarrhal haunts. The jewelled snuffbox may

replace the cigarette case or compact, sneezing parties become more common than the kaffee klatch, and the hay feverite will be forced elsewhere to seek new symptoms and performances. That anatomical depression at the base of the thumb, commonly called the "snuff box," has fallen into sad disuse—but there is still a hope that it will retain its outlines till snuff comes back.

But, you will say that I have purposely neglected so far in my story the matter of tobacco abuse. How can one, without bias, best **TOBACCO ABUSE** answer the question as to whether the tobacco habit is good or evil? It is only the fanatic and the moral prude who would immediately and unequivocally condemn all use of the weed. Yet if temperance and moderation are to be our counsels, it can do no harm to say something of the dangers of excess.

It is quite conceivable that the average man may be able to regulate his consumption of tobacco to suit his desires, and yet be interested in some of the technical facts concerning it. Modern man lives in a perpetual plethora of poisons—and it is poison that eventually upsets him. Fortunately by virtue of some adjusting influence, he is able to shield himself against their action and to accustom himself to their presence. This is particularly true of some of the most common of poisons.

There are certain drugs to which the human system becomes accustomed, which must be taken in continuously increasing amounts to produce their reactions. Such a drug is morphine and to a lesser extent alcohol. Others can learn the crave without increasing its tolerance. Coffee, tea and tobacco are of this nature.

From a former lecture on a kindred subject delivered several years ago, I quote a paragraph or two, as being specially fitting at this juncture.

Take this tobacco habit. The body cells cordially hate it when with its juices "they are first acquent." Normally the human body is antagonistic to tobacco and its ingredients. This is the proper viewpoint to take of the tobacco habit, and in this I am bound to be supported by a certain group of well-meaning old ladies of both sexes, whose present endeavor is to eradicate from this land of the free and the home of the rave the pernicious, life-destroying weed familiarly known under such nom de plumes as Camels, Cincos and cut plug. I may be pardoned for referring at this point to a strictly personal matter on the ground, perhaps, that it has been a strictly personal matter with most of the gentlemen in this audience. I

say gentlemen advisedly, although it is alleged and rumored that this pernicious habit is extending its engulfing and paralyzing tentacles into feminine circles heretofore considered immune to its vicious influences.

But that is another story—we men all agree, however, that if the weed plays fair and exacts from its lady initiates the nauseating quintessence of seasickness that it exacted from us, its primary shriners, we shall never complain. By the way the stanza that Thomas Hood left out of his immortal "I remember"—is now in public print for the first time:

THAT FIRST TASTE OF TOBACCO

"I remember, I remember
My first tobacco spree,
The little corner of the plug
That Bob bestowed on me,
Now swallow hard—that's what he said,
And I obeyed, of course;
They took me home a limpid lump,
Of over-ripe remorse."

And that, I am certain, is the common experience of all devotees of the weed when first they try its tempting lure.

Around and about the boy's first cigarette or chew of strong tobacco are pressed in never-to-be-forgotten discomfort and discontent—life's darkest, deepest moments. Generally from then on, however, devotion to the weed is certain. The antipathy exhibited to the tobacco upon the first trial is quickly changed to honest regard, and in a few weeks, months or years, the habit has so grown upon the devotee that not good sense, regard for sanitation, or even the beseeching requests of a lady love can make him forego his old corncob or his filthy cut of plug. To be satisfied with this statement one only has to watch the honest satisfaction beaming on an old man's face as he sits in his slippers by the fireside, unconsciously conducting an experiment in destructive distillation, a capacious meerschaum still, hiding his countenance, and himself filling the part of an aspirating *worm* condenser. What a wealth of content he seems to extract out of that alluring weed and not even the Shah of Persia smoking his golden chandelier is happier than the bronzed old man condensing the vapors from a clay retort, holding back that which is good and chimneying out in coiling wreaths the incondensible smoke. By the way, I am told of the invention of a smokeless cigar. As a curiosity it may be interesting, but as a commodity it is worthless. For despite

the gaudy lithograph upon the cigar band, and despite the extra coupons, no real man would ever indulge in a cigar that did not offer special attraction by way of smoke, that wisps and curls and purls and spins in endless syncopation.

But the tobacco habit, despite the fact that the body cells are eventually taught to expect their daily dose of nicotine, belongs to the class of capricious and unnecessary idiosyncracies. An exertion of the will, conducted after clever propaganda and governed by proper principles, is always able to remove such a habit provided it is conceived at a season of the year removed from the New Year, when most resolutions go up in smoke anyway.

Yet again what strikes one as a most important fact regarding the use of tobacco, is that it actually does produce substances which even the most inveterate smoker would of necessity admit to be both poisonous and irritating. Soluble principles of the chewed leaf—constituents of smoke from cigar or cigarette or pipe, all contain in some measure or another a compound, a volatile alkaloid, belonging to that group of powerful substances which numbers among its members such poisons as morphine, atropine and strychnine.

SO THIS IS NICOTINE?

This compound is Nicotine. The chemical formula of Nicotine is $C_{10}H_{14}H_2$. Its full Christian name is Beta-pyridyl-alpha-normal-methyl pyrrolidine—you will note its complexity. According to a pamphlet issued by the Life Extension Institute, "Nicotine is second only to prussic acid, or hydrocyanic, in the rapidity of its fatal effect. One cigar weighing a quarter ounce, and made of strong tobacco, contains enough nicotine to kill a non-smoker if the entire quantity be taken internally. The inimitable Slosson always emphasizes the potency of hydrocyanic acid by telling that one drop of it placed on the tongue of a dog is enough to kill a healthy man. The same can be said of nicotine.

Nicotine at first slows the heart and increases the blood pressure, subsequently the blood pressure is lowered, and the heart action becomes rapid. The "tobacco" heart is recognized by physicians as a definite pathologic condition. Cramer believes that a leech sucking blood from a habitual smoker dies in convulsions. He also believes that 100 cigarettes smoked and inhaled in one day may cause death.

Nicotine is a volatile alkaloid and since it is present in the plant as a salt (malate or citrate), it is rather readily soluble in water. The free alkaloid may be very easily released, however, from its hiding

place in the plant cell by coaxing it out with an alkali. Many smokers believe that the test to discover nicotine in tobacco is to blow smoke through a handkerchief and note the brown discoloration. This is not true. The brown color is caused by the tobacco oil which is found in all tobacco. Nicotine is a colorless, harmful drug, not distinguishable except by chemical analysis.

Recently harvested tobacco leaf contains, depending upon its source, anywhere from less than one per cent. to over five per cent. of nicotine. Recent analysis of an ordinary cigar, one of the popular sellers, made of a blend of domestic and Havana tobaccos, revealed a nicotine content of 1.48 per cent. carried out to a dry basis.

I have before me as I write a paper entitled "Investigations on Tobacco with Special Reference to Quality," by Henry M. Steece, Specialist in Agronomy, U. S. Department of Agriculture, Washington, D. C. Under his section on nicotine, he reports the nicotine content in Connecticut wrapper leaf as 2.89 per cent. after fermentation. He adds that the harsh quality of tobacco smoked is partially removed by re-sweating and ageing, "whereby the easily volatile nicotine is largely expelled." The scientific explanation of this is that the ammonia produced during the fermentation or sweating, releases the volatile nicotine.

As to Kentucky and other southern tobaccos used for pipe mixtures and cigarettes, he gives the nicotine content, for the lighter grades, such as we use in this country, at 1.54 per cent., although it ran as high as 5.56 per cent. in the grades that are used only for export.

The present generation of American smokers demands mild tobacco, with the result that all tobacco products for American consumption are made of leaf that has been well aged and that has been several times re-sweated. Therefore, analyses of tobacco in the field, hanging in the sheds, or having had only one sweat, does not truly indicate the nicotine content of tobacco that is ready for the consumer.

A most interesting table of nicotine content of tobacco appeared a few years ago in the English Medical Journal, *The Lancet.* It is apparently the result of a very well conducted piece of research. It is as follows:

	Per Cent. Nicotine in Tobacco	Per Cent. Nicotine in Smoke from a Pipe	Per Cent. Nicotine in Smoke from Cigarette
Virginia cigarettes	1.60	.60	0.12
French tobacco	2.60	2.20	0.95
Turkish cigarettes	1.38		0.51
Egyptian cigarettes	1.74		0.21
Pipe mixture No. 1	2.85	2.20	2.25
Pipe mixture No. 2	2.01	1.53	
Perique tobacco	5.30	1.27	0.57
Cavendish tobacco	4.15	3.85	
Latakia tobacco	2.35	1.20	
Havana cigar	0.64		0.20

From this analysis it appears that pipe mixtures and pipe smokes show the largest amount of nicotine.

Obviously, too, the chewer absorbs most nicotine, and the cigarette smoker the least. It is to be remembered that of the small percentage of nicotine in tobacco smoke only a still smaller portion is actually held in the smoker's system. The mild mannered and inoffensive person whose gastric equipment and respiratory department revolt against inhaling indeed absorbs but little nicotine, providing he does not too roughly treat the butt end of his cigar. Small thin cigars, which afford a small area behind the fire range, and smoked in a holder, will probably best fit such a person.

It has been my experience that the expensive eight-cylinder brunette cigars affected by the wealthy are a great deal richer in nicotine content than the modest nickel blonde.

Did some one say: "Are there not many substances other than nicotine in tobacco smoke?" Yes, indeed—furfurol, carbon monoxide, ammonia and pyridine compounds, picoline, possibly some formaldehyde, cyanogen compounds—and wood alcohol, all exist in tobacco smoke—and as stated, in amounts not always infinitesimal.

An editorial writer in a recent issue of the *Journal of the American Medical Association* had to state about this:

LISTEN TO WHAT

"The use of tobacco has been greatly extended in this country in recent years. Smoking has not only maintained its popularity among men but also is attaining greater and greater vogue among the women. The per capita consumption of the 'weed' in the United States is well

above six pounds per annum; in view of the fact that smoking is not indulged in by many people, the use of tobacco by its devotees must be expressed by far larger figures. In terms of cigars and cigarets, they involve billions every year. These facts alone warrant the securing of adequate information with regard to many aspects of the problem of tobacco smoking. Heretofore interest has been centered primarily on nicotine, a potent alkaloid present in varying quantities in the tobacco and transferred to a considerable degree—probably 30 per cent.—to the smoke produced by the combustion of the leaf. Of course, the absolute amounts of nicotine involved are small. The cost and smoker's preference of tobacco are not a good index of its nicotine content. It has been estimated, however, that a cigaret smoker who puffed away steadily for an hour might absorb as mucht as 36 mg. of nicotine if he inhaled and 27 mg. if he merely puffed. These are quantities that deserve consideration in relation to possible malaise.

"It has been demonstrated that other substances toxic in nature may appear in tobacco smoke. Among them is carbon monoxide, which may make up as much as 25 parts per 10,000 of the air. Whether the concentration of this admittedly noxious gas ever reaches a point in smoking where it becomes a physiologic menace is not readily answered. Thousands of persons will testify to the discomfort they have experienced in an atmosphere laden with tobacco smoke. Few will venture, however, to fix the blame on any single contaminant of the inhaled air.

"A new factor has been introduced by the demonstrations of Neuberg and his co-workers at the Kaiser Wilhelm Institute for Biochemistry in Berlin-Dahlem that tobacco is a potential source of methyl alcohol, popularly known as wood alcohol. The latter is not present preformed in the leaf either before or after 'curing' but is derived from the plant pectin, which is a methyl ester of a complex acid of carbohydrate origin. Pectins may yield as much as 11 per cent. of methyl alcohol. Of course no such quantities are derivable directly from tobacco, which includes many constituents besides pectins. Nevertheless methyl alcohol is detectable in measurable amounts in tobacco smoke, although it might have been assumed that the readily oxidized compound would be destroyed completely in the combustion of the leaf. Under the conditions of actual tobacco smoking as practiced by man with cigars and cigarets, Neuberg and Ottenstein found that not more than one tenth of the methyl alcohol entering the body with the smoke was exhaled again with the expired air. Most of it seemed to remain dissolved in the fluids, notably the saliva moistening the buccal and respiratory passages.

"The possible physiologic significance of the new discovery (which has already been heralded in the newsprint under cap-

> tions permitting the conclusion that ordinary, ethyl, alcohol is involved) hinges on the quantities of methyl alcohol involved. According to the German calculations, a smoker who consumes ten cigars of average size daily burns up about 70 gm. of tobacco and inhales about 42 mg. of methyl alcohol. Cigaret tobacco gives a larger yield, so that the smoking of twenty cigarets containing a total of only 20 gm. of tobacco will likewise lead to the inhalation of 40 mg. of the alcohol. These are not toxic doses. Whether they can produce synergistic effects for harm, or, in view of the resistance of methyl alcohol to oxidation in the body, they can exert cumulative effects remains to be learned. As Neuberg has further summarized the problem, it must be remembered that vaporized methylated spirit may act quite differently in combination with other tobacco poisons than it would alone."

We have dealt gently with the cigarette when used in sensible numbers, but according to a recent authority, an inhaling fool can show an absorption of as high as 5 per mille of carbon monoxide in the blood stream. A recent medical investigator found nicotine in the breast milk of smoking mothers, and nicotine should certainly be no part of a baby's diet. Tax figures for last year show that the consumption of cigarettes in this country has vastly increased, due it said, to my Lady's addiction to this form of tobacco.

Dr. G. L. Schneider, optometrist of the University of California physics department, indicts tobacco because of the harmful effect of nicotine, etc., on the eyes. "Those who practice the science of optometry have definite proof that excessive smoking is detrimental," he said. "Toxemia is the frequent result; and toxemia resulting from over-smoking is not only one of the greatest factors in eye trouble but it is on the increase. Furthermore, tobacco poisoning, whatever the composition of the poison may be, is most severe in young people."

THE INDICTMENT OF MY LADY NICOTINE (CONTINUED)

Sir Humphrey Rolleston of the medical faculty of Cambridge in a recent lecture before the Harrowgate Medical Society has summed up the existing evidence pro and con as to what tobacco actually does to one, with the conclusion that it is not so bad as many would have us believe. There are several outstanding features, however, that are not so reassuring. Psychological tests show that smoking lowers mental efficiency from 10 to 23 per cent. While these results are not conclusive, said Sir Humphrey, it shows a definite lessening of capacity to work. It is also suggested that prema-

ture senility is induced in heavy smokers by the sedative action of nicotine on the nervous system.

Experimentally it produces definite degeneration of the arteries in rabbits, but authorities believe that if tobacco smoking is really a cause of arteriosclerosis, it is a slow one, so mingled with the general conditions of old age that discrimination of the actual factors are almost impossible.

"The effect on the stomach," said Sir Humphrey, "is important; X-ray bismuth meals have shown that after a short period of increased contractility the motility of the stomach becomes paralyzed for an hour or so; as the subjective feeling of hunger very probably depends on contractions, the relief of hunger by smoking may thus be explained; it is said that dilation of the stomach may thus result."

Don't inhale when you smoke if you want to get good grades, is the advice given to students by J. Rosslyn Earp, of Antioch College, who has just investigated the long-run effect of tobacco on college men. As a result of his research, he announces that those students who inhale the fumes of tobacco, regardless of whether they smoke much or little, have lower scholarship records than smoking students who do not inhale.

This fits in with the statement of a German scientist, who recently reported that inhalers take into their systems eight times as much nicotine as smokers who do not inhale.

Dr. Bainbridge (*The Cancer Problem*), an authority on cancer, states:

TOBACCO AND CANCER

> "The mouth is a common seat of malignancy because of the wide possibility of irritation.
>
> "A very common source of irritation associated with cancer of the lip and tongue arises from smoking. The pipe, cigar, or cigarette, being always held in the same position, by mechanical irritation, by burning, or perhaps as suggested by Lazarus-Barlow, by radio-activity, seems to start the erratic cell growth which terminates in cancer. It is important, therefore, for persons who cannot resist the inclination to smoke, to vary the position of the pipe, cigar, or cigarette and thus diminish the possible danger of cancer."

Where there is in one's immediate ancestry history of lip or tongue cancer, smoking should be very moderately done. Better for such a person is complete abstinence from it.

But, states the confirmed yet temperate tobacco smoker, excess is injurious with anything. Too much pie, too much pudding, too much tea, too many baths, too many mud-packs, too much money—all are injurious.

And that is possibly the sane viewpoint to take.

For, mind you, tobacco has also its virtues—and they must not be overlooked. Most guardedly I say that it is antiseptic—or according to the Bureau of Chemistry—it is bactericidal. But let us not forget that this, after all, is only indirect evidence of its toxicity. Oddly enough, however, the digestive enzymes of the saliva and stomach fluid seem to function better in its presence than they do without it. One drop of Nicotine, added to an acid pepsin solution hastens the digestion of coagulated albumen immersed in it. Pancreatin also more rapidly hydrolizes starch iodide when nicotine is added to it. But these things are observable only in glass stomachs—in the flask and test-tube. There is a difference of opinion among smokers as to tobacco's effect on digestion.

Sour stomach, or excessive production of gastric acids is the penalty paid by some for over-indulgence. Others are seemingly benefited by an after dinner smoke. Nevertheless it is generally accepted by physiologists that excessive use of tobacco is *not* good for digestion, in that it inhibits or prevents the secretion of the digestive ferments. So, no matter what essence of tobacco may do in a test glass its reaction in the gastronomic apparatus is a totally different story. It is said that during the flu epidemic smokers and chewers were less commonly struck than non-smokers, because their respiratory tracts were made sterile with nicotine and other products of tobacco maceration or combustion. This I doubt.

Tobacco is said to be remedial in certain kinds of disease—yes—and this was one of its first uses. Wondrous properties were ascribed to its medicinal use and some of the old herbals describe its value, as the drug Petum, in a way that would be highly creditable to the modern advertiser of a patent medicine. It cured anything from an ingrown toe nail to a fit of alcoholic doldrums. Among the many medicinal virtues attributed to tobacco, was its supposed value as a preservative from contagion in times of plague. There were many references to this in the various descriptions of the Great Plague of 1665 and importance was attached to the fact that sellers of tobacco suffered less from the plague than any other shopkeepers. Certainly smoking was encouraged, was even made compulsory, as is

seen by the fact that at Eton in that year all the boys were obliged to smoke in school every morning.

It seems certain, however, that tobacco does possess some medicinal virtue. Anyway it is a good emetic as most of us have self-proven. Six or eight grains of it will cause the stomach of a normal person to heave its contents in a perfectly perpendicular direction.

It has been demonstrated scientifically that most of its body reactions are actually due to an increased secretion of epinephrin or adrenalin. This may account for its value in asthma powders. During the Civil War and more latterly during the World War, some draftees tried to evade service by placing lumps of tobacco in the armpits, whereby they were temporarily much sickened and weakened and possibly on that account rejected for active service.

SOOTHING AND CHEERING IS MY LADY'S CARESS

But it is from a psychologic standpoint that tobacco shows to best advantage. "To the sleepless, the worried, to him or her who is troubled in mind or vexed in spirit the pipe or cigar is a never-failing remedy to soothe and to cheer." Some men can only smoke when they have companionship, and the well-known soothing effect of cigarettes on the wounded can hardly be attributed to the amount of nicotine absorbed. Smoking does seem to have a certain effect on the higher intellectual centers. After a transient preliminary stimulating effect on mental processes, its sedative effect develops.

How effectively the poet, whom I quote, has sung its praises, though one doubts that tobacco could of itself produce such a fine hallucination:

> "A few more whiffs from my cigar
> And then in Fancy's airy car
> Have with thee to the skies.
> How oft the fragrant smoke upcurled,
> Hath borne me from this little world
> And all that in it lies."—*Hood.*

Its companionship and sociability is frequently emphasized by the writers since Sir Walter Raleigh, and in coffee houses were seen evidences of this more than perhaps anywhere else. "I was yesterday," says a writer in the *Spectator* in 1714, "in a coffee house not far from the Royal Exchange, where I observed three persons in close conference over a pipe of tobacco; upon which, having filled one for my own use, I lighted it at the little wax candle that stood before them; and after having thrown in two or three whiffs amongst

them, sat down and made one of the company. I need not tell my reader that lighting a man's pipe at the same candle is looked upon among brother-smokers as an overture to conversation and friendship."

The close affinity between the smoke and a book is well illustrated by the remark of Lamb, in one of his letters to Coleridge, "If you find the Miltons in certain points dirtied and soiled with a crumb of right Gloucester, blacked in the candle (my usual supper) or, peradventure, a stray ash of tobacco wafted into the crevices, look to that passage more especially: depend upon it, it contains good matter." Lamb was a great smoker and thoroughly enjoyed reading only when he was smoking. He was asked once how he could smoke so much and so fast, to which he replied "I toiled after it, sir, as some men toil after virtue." It was Lamb who coined the famous couplet:

For thy sake Tobacco I
Would do anything but die.

Propositions to take alcohol out of beer and ale and liquors, and to take caffeine from tea and coffee, have not met with much favor—yet a recent discovery whereby nicotine is said to be removed from tobacco by a vacuum process without impairing its flavor may meet with a warmer reception. If it is true that nicotine or its combustion compounds play no part in the flavor or in the action of tobacco its removal should be helpful.

The Persian, when he smokes his elaborate pipe, or the Indian with his narghilli, wisely purifies the fumes by bubbling them with water. Even the methyl alcohol could thus be removed. The long-stemmed clay pipe absorbs the noxious matter and so does the corncob contraption, but oh! when such pipes attain to senility—how atrocious they get. An old pipe is a two-fold atrocity. It has lost its defensive absorption value for the nicotine, and it has gained in offensive putrescence. 'Tis the resident of Galway or County Antrim, begorra, that knows how to smoke the pipe—and a short clay pipe he chooses—so short that the bowl burns his proboscis. And none but O'Harritty could handle that contraption, bowl downwards, yet never spilling the tiny wad of shag—till every atom of it goes up in smoke.

Tobacco smoke passed through tannin loses all its nicotine. I do not know whether the Tree Heath pipe of Corsica or the briar of Brittany owe their effectiveness to the fact that they contain

much tannin or not, but did I indulge in piping I should prefer one made with a nut gall bowl and stem of pressed filter paper.

Another novelty in the tobacco line is artificial tobacco as reported in a French journal, *La Nature* (Paris):

SYNTHETIC TOBACCO

> "Thin sheets of especially prepared paper are impregnated with nicotine, stained to the proper dark-brown color with dyes and perfumed with chemicals so that they have the proper tobacco odor, both before burning and when alight. Nicotine, the powerful oily drug which is the active principle of tobacco, was made synthetically some years ago by German chemists, so that there would be no difficulty about obtaining this drug for impregnation purposes, even without using any tobacco leaf at all. What oils or other chemicals are used to impart the necessary odors is not stated in the account. While the making of an artificial tobacco in this manner appears to be entirely possible, and probably cheaper than growing and curing the natural leaf, it may be considered doubtful whether smokers anywhere will accept the substitution happily."

I have been requested to say something of cures for the tobacco habit. In response to the request I submit the following episode: "My husband," remarked a Philadelphia matron to a group of friends, "was a confirmed smoker with a real tobacco heart when I married him five years ago, but now he never touches the weed."

"Great," said one of the group, "to break off a lifetime habit like that requires a powerful will." "Well, that's what I've got," said the wife.

But in the absence of a "powerful will," rinsing the mouth with a one-fourth of 1 per cent. solution of silver nitrate is said to be effective.

Oil of sassafras, diluted with alcohol, is also said to depress a tobacco appetite. So too does an attack of influenza, though only temporarily. But, all in all, the "cures" seem more offensive than the disease.

You've heard the story of the young gentleman who confessed to a none too gracious lady friend that he had been advised in early youth to quit smoking cigarettes else he'd be feeble-minded when he grew up. Her answer was: "Well, why didn't you quit?"

And so I bring my Story of Lady Nicotine to its close. I have exposed her virtues and her vices, yet in spite of all this, history

shows that it matters little whether the tobacco habit is condemned or not, for it has survived more than one determined attempt at its prohibition. The "tobacco question" will only cease to be a problem when the millenium of common sense arrives. In the meantime, there will be enough difference of opinion to give rise to such quaint reflections as those recorded in the writings of the melancholy Robert Burton, whose words go something like this:

> "Tobacco, Divine, rare, superexcellent tobacco, which goes far beyond all the panaceas, potable gold and philosopher's stones, a sovereign remedy to all diseases, a virtuous weed if it be well qualified, opportunely taken, and medicinally used—but as it is commonly abused by most men who take it as tinkers do ale, 'tis a plague of mischief, a violent purge of goods, of lands, and health, the ruin and overthrow of body and soul."

SAND—FROM MOUNTAIN TO SEASHORE

By Edward J. Hughes, P. D.

Assistant Professor of Chemistry

IT SOMETIMES happens that the common things of everyday life are those about which we know very little, and it would be difficult to select a more common substance than the one that we are to consider briefly this evening. Every one is at least familiar with sand, comparatively few have taken the time to reflect upon its origin, its history and its many applications to human progress.

Edward J. Hughes, P. D.

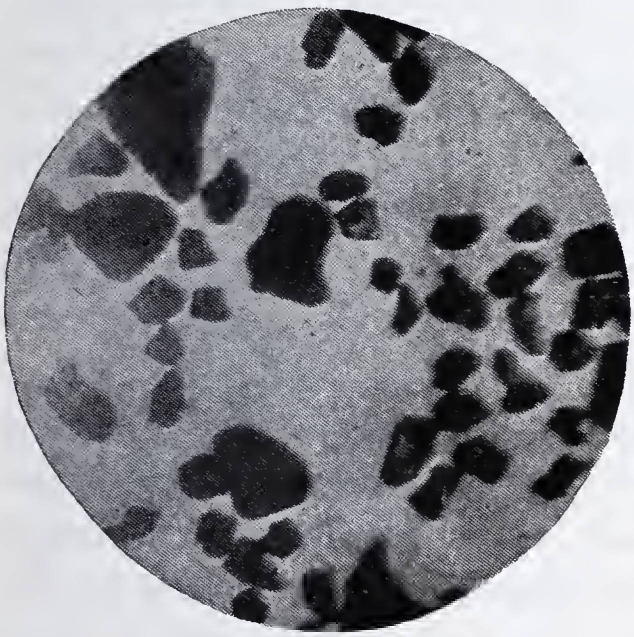
To begin with, sand is not always a pure substance, nor is it considered to have a definite composition. For example, the sand from Bermuda is chiefly composed of carbonate of calcium, while the monazite sand of India, Brazil and the Carolinas contains compounds of the rare earths. But the ordinary sand with which we are concerned is that which now covers hundreds of thousands of square miles of the earth's surface and which is chiefly composed of silicon dioxide, or silica, in the form of broken grains of crystalline quartz.

Sand is produced by the crumbling of the outer surface of the earth's crust, which has been going on for countless ages. As the original or primary rocks have been exposed they have undergone chemical and mechanical disintegration. Even today the stalwart rocks of mountain ranges, such as granite and feldspar, are being laid bare by weathering agencies only to be attacked by water, carbonic acid, quick changes of temperature, frost and lightning. This treatment tends to split and to disintegrate the rocks, reducing them to fine particles. The powdered material is washed away as clay or mud, while the quartz, which is more resistant and does not undergo further chemical disintegration, remains in the form of broken fragments and becomes sand. A considerable amount of this sand finds its way into the soil, but a very great portion of it is carried by streams into rivers and subsequently into the sea. In desert regions where the broken-down particles cannot be washed away they are blown by

the wind, with the result that the grains of sand become well worn and rounded. It is obvious then that Nature's chief transporting and sorting agents for sand are wind and moving water. So thorough is

Beach Sand x 80, Atlantic City.
(Note Rounded Outline.)

River Sanu x 80.
(Note Partly Rounded Edges)



Sahara Sand x 10.
(Note Jagged Edges)

Whistling Sand x 25.
From Coast of Wales.

this sorting process that known deposits of sand have been found which contain up to 99.9 per cent. of silica.

In deserts and other dry inland regions where loose sand is exposed to the wind the sand accumulates in hillocks and these are known as sand-dunes. These dunes are moved about by the wind and

they form the rolling hills of the desert. In some respects the shifting sand-dunes of the desert are comparable to the waves of the sea. They give serious trouble when they invade fertile and inhabited country, and there are places along the shores of Lake Michigan where they have actually buried swamps, forests and even low hills. In some localities efforts are being made to check their progress, as in the southwest, where railroad companies are temporarily fixing the dunes by spraying them with crude oil. In this connection it is interesting to note that the city of Amsterdam in Holland derives its water supply from sand-dunes that have been erected by wind and wave action along the Netherland coast. This particular section is composed of rather loose sand, in which the city water department plants tufts of reed grass in order to keep the sand from shifting.

SAND AND SOIL

Life is sustained on the earth by the mantle of fertile soil which has also resulted from countless ages of rock disintegration together with the decay of animal and vegetable matter. Sand is an essential factor in good soil, since it tends to keep the soil loose and open. It adds very little, if anything, however, to the nutritive value of the soil. This will be seen from the fact that while silica constitutes more than half of the mineral matter of the soil, yet plants yield from 2 to 10 per cent. of ash when they are burned, of which only about one-twentieth is silica. Some people have the impression that sandy soils are more healthful than those deficient in sand, but more compact soils are warmer than those containing excessive amount of sand. There is a considerable amount of air in sand, and air is a poor conductor of heat, therefore the heat does not penetrate deeply into the sandy soil where it could later be slowly given up.

Imagine, if you can, the vast ages of time that were involved in the formation of a piece of sandstone such as is used in the construction of a building. Sandstone is made up of grains of sand which have become compacted together by a cementing material and by the weight of other sediments above them. The original sand grains have been worn off the surface of some older rock such as granite as a result of long ages of weathering. They have then been carried away by streams and laid down in deposits along the streams or upon the sea floor and are covered by later formations. The cementing material varies in composition, but is chiefly composed of gelatinous silica, which gradually deposits from solutions upon the sand grains and becomes very hard. The individual grains of such a stone are

chiefly composed of quartz, the small particles of this mineral remaining intact because of their hardness and resistance. Large beds of sandstone have been found in New York, New Jersey, Massachusetts, Connecticut, California and Ohio. An immense bed of unusually fine sandstone is being quarried at Berea and Amherst, Ohio. This particular stone has been shown by chemical analyses to contain about 97 per cent. of silica and has been used in the construction of such prominent Philadelphia buildings as Horticultural Hall, the Academy of Fine Arts, University of Pennsylvania and the Academy of Natural Sciences.

Nearly all of the known sources of petroleum oil and natural gas are found in deposits of sedimentary rocks, and chief among these oil-bearing rocks is sandstone. According to the most generally accepted theory, petroleum has originated from animal and plant remains which have become buried in these sandy rocks. The hydrocarbons in petroleum are believed to have evolved and accumulated in the rocks by a process of decay and are held in the deposits of porous sandstone by other layers of impervious rocks or by hydrostatic pressure. California's production of two hundred and thirty million barrels of petroleum oil in 1925 was made possible by deep sand-drilling in the Ventura Avenue section of the Los Angeles basin. Much of this oil was drawn from sandstone at a depth of 5150 feet.

WHEN SAND MEETS STONE

Under the influence of the wind, sand has done much to wear away the rocks and the crags of the earth especially along the seacoast. There are places along the shore where window glass loses its transparency in a few days. The obelisks in Egypt have been worn away on the sides exposed to the sandy area, and even telegraph poles have been cut down in Southern California by the cutting and gnawing effect of sand-laden winds. Such observations as these have led to an industrial application of sand in what is known as the sandblast. Stone buildings are sometimes cleaned by blowing sand upon them with a powerful blast of air or steam. This procedure is called sandblasting and is also employed in frosting glass and in engraving metals and tombstones. The sandblast furnished one of the earliest methods for redressing the outside of a building. By this means the surface of the stone is removed and a fresh and unstained surface is brought to view. But serious damage may result to many fine buildings through sandblasting operations. This is especially true of buildings faced with limestone. While restoring the surface to its outward

appearance of newness, the sandblast cuts away not only the accumulations of dirt and grime but also the outer skin of the limestone that was formed during the process of seasoning. When the pores of this outer surface are removed or opened, Nature's armor against the elements is destroyed and the stone is rendered vulnerable to attack by frost action and the weather. The sandblast would also remove the glazed surface of terra cotta, exposing the porous material beneath to the ravaging effects of weathering.

An American Sahara from the Air, Death Valley, Cal., U. S. Army Air Service.

In a recent bulletin of the United States Geological Survey it has been estimated, as a result of thousands of analyses, that silica constitutes approximately 60 per cent. of the crust of the earth. Of course not all of the silica is there in the form of sand. In fact, much of it is combined with metals in the form of various silicates such as feldspar and mica. It is interesting to note, however, that among the other minerals that have a composition similar to that of ordinary sand are agate, amethyst, onyx, flint, quartz, opal, diatomaceous earth jasper and some others that are not commonly known. Geyserite, a

mineral which has deposited from certain spring waters in Yellowstone Park, and silicified wood, from the petrified forests of Arizona, are also chiefly composed of silica. Thus, sand is only one member of a great silica family that constitutes more than half of the outer shell of our planet.

THE FLOOR OF THE SEA

A very interesting form of silica is the diatomaceous earth which is also called infusorial earth and kieselguhr. This fluffy, white substance is used as a packing and polishing powder and also as an absorbent for nitroglycerin in making dynamite. Like sand, it is composed of nearly pure silica and constitutes the remains of multitudes of minute organisms called diatoms and radiolaria. These microscopic organisms extract and secrete silica from sea water just as the shellfishes do calcium carbonate. They live in the upper layers of the water, but after death their remains sink to the bottom of ponds or of the sea and there form a deposit. It is believed that the greater portion of the floor of the sea is covered by a red mud containing 60 per cent. of sicila, and it is significant that igneous or primary rocks contain silica in about the same proportion.

In considering the immensity of sand deposits one immediately thinks of the great deserts of the earth. It is in these vast white plains of sand that nature seems antagonistic to everything that lives. It has been computed that the sandy zone traced throughout the breadth of the ancient continents covers an area of about 6,500,000 square miles. And what unspeakable suffering and tragedy have been buried in the silence of the desert. A recent automobile expedition that crossed the Sahara reported traveling for over 300 miles without finding a single drop of water. The sand of the desert becomes unbearably hot during the day and often cools down below the freezing point at night because sand has a low specific heat which prevents it from storing up the heat from the sun's rays. If the soil of the Sahara, for example, contained its normal share of water and were more compact, the heat of the day would penetrate downward and would be given up at night, thereby making the nights warmer and the days cooler than they now are. The nearest approach to the Sahara in America, as regards sand-dunes, heat and aridity, is the East Mesa of the lower Colorado Desert in Southern California. A member of a summer surveying party took a walk in this desert one evening, intending to go around one of the sand hills, and was found two days later hopelessly insane.

On the other hand, there are desert areas in our own country that are being converted into fertile fields by irrigation. In some sections, as for example in the Imperial Valley of Southern California, the reclamation projects have actually succeeded in making the "desert blossom as the rose."

A new desert has recently been discovered in the State of Maine within twenty miles from the city of Portland. Less than a century ago this particular land was a fertile farm section, but the fertile top

America's Sahara, The Colorado Desert with San Jacinto Mountain in the Distance. Photo by J. S. Chase.

strata has washed away, exposing a bed of sand, which has since been spreading year by year over the surrounding country. This site is about five miles from the sea and is probably the bed of a long-departed lake.

Nineveh, Babylon and other ancient towns and cities of central Asia are today entombed in sand which has been carried from the desert by the wind, and along the west bank of the Nile are many other towns that are submerged in sand. The discoveries of the

future that will throw light upon the history of these ancient peoples of the East are probably hidden at this moment under the sands from Mesopotamian and Arabian deserts.

There are gems of real beauty that are similar to ordinary sand in composition. Among these is the perfectly clear rock crystal which, in addition to its value as a gem, is highly prized in making fine grade lenses. The purple amethyst belongs in this group and owes its color to the presence of a trace of manganese. The precious opal is essentially composed of silica together with some combined water. In appearance the opal somewhat resembles mother-of-pearl, but shows a brighter play of colors due to the presence of a multitude of little cracks whose angles break up the light reflected off the surface. Such a color is purely physical and would be totally destroyed if the opal were reduced to a fine powder. The agate is another beautiful form of silica which when cut across shows fine concentric lines and colors which vary to correspond with each successive layer of material.

SAND AND PERPETUAL MOTION

Some very curious facts have been learned with regard to the presence of included gases or liquids, or both, not only in sand but also in other forms of silica such as quartz and amethyst. The sea sand of New Jersey frequently contains microscopic cavities partially filled with liquid and each containing a tiny bubble of gas. A single grain of sand may show a large number of these cavities if the bubbles are sufficiently small, and they generally show a continuous vibratory motion known as the Brownian movement. In a variety of blue quartz found in Bucks County, Pa., the liquid inclusions contain, in addition to a bubble, minute crystals which are in constant motion, a motion which has been continuous for possibly millions of years. On the other hand, a large pocket of sand was recently discovered in a solid block of marble at Middlebury, Vt. This sand resembles beach sand, and geologists say that the marble was formed under water and the sand was probably caught in the center of the formation.

With enormous quantities of sand at our disposal, one might ask the question, "What is it good for?" But if we consider its importance in the manufacture of glass alone we find that sand justifies itself as one of the earth's greatest endowments toward the progress and the convenience of mankind. From a very remote period to the present day too, white sand has been the chief ingredient in the manufacture of glass. In making glass, a mixture of sand, limestone and

soda ash is heated to a high temperature until it forms a clear, syrupy liquid, which solidifies on cooling to form a transparent solid. For a long time Pennsylvania has ranked as the leading State in the production of a glass-sand as well as in the production of quartzite for silica refractories. The most productive area has been in the center of the State, chiefly in Huntingdon, Mifflin and Blair Counties.

Sand is also one of the major constituents in the production of pottery and earthenware. Here the chief functions of sand are to reduce shrinkage and to impart rigidity. The unusually low coefficient of expansion of the silica, especially after firing the mixture, also protects the ware against breakage when exposed to quick changes of temperature.

Enormous quantities of sand go into the production of concrete, which is a form of artificial stone that is largely used in the construction of buildings and highways. Concrete is made by mixing together sand, gravel, Portland cement and water until the mass has the consistency of gruel, then dumping the mixture into wooden forms and allow it to solidify.

SAND IN PUBLIC HEALTH SERVICE

Sand occupies an important place as a protector of public health in the purification of drinking water, since large quantities of good, even-grained sand are now used in the filtration of municipal water supplies. This process involves more than the simple straining of the water, otherwise disease-producing bacteria might pass through the spaces between the sand grains very easily. But in addition to holding back suspended matter, there is formed on the sand grains a slimy, jelly-like material which serves to entangle and to hold bacteria and minute suspended particles of all kinds. The absence of this gelatinous coating on the sand grains, as for example in sand which has been cleaned, actually lowers the efficiency of the filter-bed. In fact, it has been found that were it not that the filter becomes almost impervious to water it would be better not to remove the dirt and the slime that accumulates.

The relative hardness of sand makes it valuable as an abrasive and it is often used for this purpose in the form of sandpaper and sandstone. In making sandpaper the sharp or rough-edged grains of sand are especially desired. One of the greatest modern applications of sand is in the manufacture of that unusually hard and exceedingly useful artificial abrasive called carborundum. Chemically, carborundum is composed of silicon carbide and about twenty thousand tons

of it are now produced annually by the reaction between pure glass sand and finely ground petroleum coke at the high temperature of the electric furnace. Sand constitutes more than half of this furnace mixture, which also contains small amounts of common salt to aid in the fusion and sawdust to render the heated mass somewhat porous.

The fact that sand will form an easily melted substance when strongly heated with limestone gives it an important place in the smelting of certain ores. A substance which reacts with the impurities of an ore to produce a material that can be easily melted and removed is called a flux. If the impurities in the ore are sandy the flux would be chiefly limestone, and if, on the other hand, the impurities are chiefly of a limestone nature the logical flux would be sand. The melted mass that flows away and so concentrates the ore is known as slag.

When pure glass sand is strongly heated by itself in an electric furnace it becomes plastic and cohesive and may be shaped into dishes. flasks and tubing. This material is known as fused silica ware and is now extensively used in chemical laboratories because of its resistance to most chemicals and to quick changes of temperature. Silica ware may be white and opaque, due to the presence of countless bubbles of air, or it may be transparent as the result of complete fusion. The transparency of this latter variety has been found sufficient to enable one to read a page of printed matter through a block of it ten inches thick.

These few thoughts are sufficient to at least suggest the importance of sand in the natural and the industrial world, for here indeed is an accumulation of the ages, and a boundless store of raw material that is being drawn upon year by year for the increasing needs of man.

WHAT SHALL I WEAR?

By Freeman P. Stroup, Ph. M.

Professor of Chemistry at the Philadelphia College of Pharmacy and Science

PERHAPS the most important questions that any animate being can ask itself are "What shall I eat?" and "What shall I drink?" These are about the only questions that animate beings other than man are apt to propound, for the Creator has provided them with some kind of covering or another, the changing of which for something else, or the discarding of which, is not a matter of choice with them. Man is about the only animal not provided naturally with a covering, hence is often under the necessity of providing himself with one. He is the only being to whom an answer to the question "What shall I wear?" has any value. There are times, indeed, when the answer to this question is of greater immediate importance than answers to the questions concerning food and drink, and there are times when an answer to it is quite immaterial.

Freeman P. Stroup, Ph. M.

A number of years ago scientists and some lay people were tremendously interested (at least they pretended to be interested) in Einstein's Theory of Relativity, but very few could honestly claim to understand very much about it. In an attempt to give other people an inkling of what it was all about, somebody said that, according to the Einstein theory, a man cannot know where he is unless he knows what time it is, nor can he know what time it is unless he knows where he is. So it is with the answer to the question "What shall I wear?" "It all depends." Depends on what? Well, on a whole lot things, as we could show if we had the time.

Some folks would answer at once with the word "Clothes," but we wear many other things besides clothes, and our characters are judged very often by what we wear, or do not wear, besides clothes, just as they are often judged by the clothes we wear, or do not wear. However, clothes seem to be the most important of the things men

and women wear, so we shall concern ourselves mainly with the question of clothing and clothing materials.

Those who trace the early history of the human race only through the Biblical account will tell us that the first recorded instance of the wearing of clothes is that mentioned in Genesis, where we read that Adam and Eve sewed fig leaves together and made themselves aprons. The inference is that the thing that prompted this beginning of the garment-making industry was the sudden realization that they were naked in the eyes of each other and of their Creator. Here we have developed one of the chief reasons for wearing clothes, that of hiding from the gaze of others portions of the human anatomy. Ideas as to what portions should be hid differ among different peoples and, indeed, among the same peoples at different times and stages in their existence. Compare the styles of women's garments of today with those of only a few years ago. Is it any wonder that manufacturers of fabrics for women's clothing who were prosperous a few years have gone into bankruptcy, or are on the verge of it now? Again, compare the man who dare not appear in a public dining-room without being encased in a coat and various other articles of apparel, no matter what the temperature, with that same man an hour or so earlier or later on the bathing beach, surrounded, possibly, with persons of all ages and both sexes. What shall I wear? It all depends.

THE FIRST "GARMENT WORKERS"

When we go back to our Biblical story we find that fig leaves constituted the materials first used for the manufacture of human garments. Doubtless, there were in the Garden of Eden trees and plants of many sorts. Knowing somewhat of the nature of trees and plants and how they vary as to the size and shape of their respective leaves, we are prompted to ask why fig leaves should have been chosen. Had the first designer of garments been concerned only with the matter of providing an opaque covering for the human body she (Eve was possibly the first seamstress) could have selected very much larger leaves that would have required less stitching (an important consideration when one remembers that sewing needles, not to mention sewing-machines, and thread had not yet been invented). From trees she could have selected catalpa leaves, and from plants she could have chosen rhubarb, elephant ear, shunk cabbage, or even ordinary garden cabbage (Jiggs not having yet appeared upon the world's stage). All of these offer large expanse of surface with rather regular and plain edges. Other possibilities might suggest

themselves to a visitor to Horticultural Hall in Fairmount Park. But she chose fig leaves, and the quesiton arises, "Why?"

Perhaps it was their decorative irregularity of outline. For a fig leaf has other features than that of opacity. Recall the outlines and then try to imagine the possible ways of sewing a number of the leaves together. The curved edges and deep indentations suggest a number of arrangements which would appeal to the eye of the beholder. Thus we have developed a second feature of clothes—their decorative possibilities. It is not apparent at just what time of the year this fashioning of raiment began, so we do not know whether the leaves were yet green or whether they had assumed an autumnal hue. If green at first we can be assured that they changed color within a few days after having been plucked from the parent stem, and their wearers had their first experience as to the becoming or unbecoming effects of different colors in juxtaposition with skins of different colors. To this day the decorative effect of clothes is chiefly dependent upon the color of the fabric used, the arrangement of pieces of the fabric or fabrics, and the harmonizing of the color and texture of the fabric with the complexion of the wearer.

Returning to the fig leaf garments, we can assume that, because of the difficulties attendant upon sewing with thorns for needles and grass for thread, the makers may have simply overlapped the edges of the leaves and caught them only here and there with a stitch, using only stitches enough to hold the leaves together and give the garments the desired opacity. This would leave slits through which air could circulate more or less freely, an important consideration in the fabrication of clothing to be worn in semi-tropical or tropical climates as may have been that of Eden. Even in rather cold climates a certain amount of air circulation makes for comfort and health.

A little later on in our Biblical story we read that Jehovah made for Adam and his wife coats of skins and clothed them therewith. What inferences may we take from this statement? Are we to assume that such attenuated raiment as aprons of easily torn leaves did not meet with the Creator's approval? If so, on what grounds? Lack of covering power? Lack of wearing power? Perishability? Frivolity in design? Approaching colder weather?

Again, whence came the skins? From animals? If so, why the great fuss made by those who oppose the killing of birds and animals in order that their plumage, fur or skins may be fashioned into human raiment? If from plants, what plants? Whether or

not the record indicates the first use of animal skins for clothing humans, the fact remains that furs and leathers have been in use for that purpose for perhaps countless ages. In very cold climates they are practically indispensable. In the warmer sections of the world they are often used solely for their decorative possibilities.

The three chief functions of clothes are (a) Concealment, (b) Decoration, (c) Protection.

With the decorative we are not particularly concerned tonight. Tastes differ so much, styles change so often, and it is so much a matter of either personal opinion, tribal regulation, or social custom that one cannot say much of anything constructive about the matter. When it comes to discussing the decorative features of women's raiment, a "mere man," particularly an unmarried one, is generally treading on dangerous ground. We shall stay off.

With the concealment features we are more concerned. Those who really wish to conceal any portion of their anatomy can do it effectively with but little in the way of fabric, while it is possible to appear practically naked under volumes of fabric. How to attain concealment without undue discomfort is a problem worthy of attempts at solution.

Practically all fibers used in the manufacture of fabrics are more or less opaque, give a more nearly opaque thread when spun, and a still more nearly opaque fabric when the threads are woven or knit together. Even with the thinnest of sheer fabrics which are nearly transparent in single layers, it is possible to fashion garments that are quite opaque, at least in reflected light, though sometimes far from it in transmitted light. It frequently makes quite a difference whether observer and source of light are on the same or opposite sides of the one observed.

What shall I wear to protect me against cold? There is no such thing as cold. It is only the absence of heat, hence any material that

CLOTHES FOR INSULATION

would be considered "warm" is really not any warmer than its surroundings, but acts as a conservator of bodily heat—shuts heat in. To shut in heat a material must be as nearly as may be a non-conductor of heat as to its fiber, and the weaving, felting, or other means used in making the fabric, must have been such as to insure a minimum degree of porosity. Most commonly used fibers are poor conductors of heat, hence most closely woven, knitted or felted fabrics should make warm garments. Wool is generally considered to be the warmest,

while linen is perhaps the coolest as it is quite a good conductor of heat. It would be difficult to say, however, how much of the reputed warmth of woolen garments is due to the non-conductivity of the fiber and how much to the manner in which the fibers are brought together in the fabric made therefrom. Some woolen garments give the wearer a sense of coolness. Particularly may this be noted in new knitted underwear that has not had its fibers matted or felted together by a number of trips through the laundry. In the new garment the fibers may be seen as having been twisted into threads or yarns and these woven or knitted into a fabric, with porous spaces between adjoining threads. Particularly is this true of so-called "worsteds." In the old garment the fibers are more or less matted together and the large pores of the new garments are replaced by very small ones in the old one, and air circulation is impeded very much where it was quite free before. Even in new garments there is a greater sense of warmth to be derived from fabrics tightly woven or knitted with loosely-spun yarns than from fabrics loosely woven or knitted from tightly-spun yarns. The thickness and weight of a fabric are not such determining factors in the matter of warmth as is the closeness of contact between and among fibers. Two layers of a thin fabric with an air space between them affords better protection than does one layer or thickness of fabric of double the weight. Air is a poor conductor of heat, and any heat that penetrates the first layer of fabric will lose most of its force ere it penetrates the air between the two layers of fabric. Moderately loosely fitting clothing feels warmer than that which is tight-fitting because of the greater thickness of the air layers between the several folds of cloth in the garments, as well as those between the inner garments and the wearer's skin. This is particularly noticeable in gloves and shoes. Again, tight-fitting garments, particularly gloves and shoes, may check blood circulation in the skin, and thus reduce external body temperature.

In cold temperatures the prime function of clothing is that of conserving body heat, and if one can do that with clothing he will need no heat from the outside. If people wore more heat-retaining clothing in these days the fuel bills of the average home would be decidedly lower than now, and there would be less grumbling about cold offices, stores and street cars. The temperature of the human is about 99 degrees Fahrenheit, but we all complain vigorously when air temperatures rise much above 80 degrees. The function of artificial heat in our homes and places of business is really not to warm

us—we are already very much hotter than we would wish the temperature of our habitations to be—but, rather, to prevent too rapid a dissipation of our body heat; and whether we feel hot or cold at any time is altogether dependent upon whether our bodily heat is being lost too slowly or too rapidly. At the present time women and men working in the same quarters, or worshipping in the same church, frequently come into conflict, with one group wanting windows open and the other group insisting that they be kept shut. Either the women are wearing too little or the men are wearing too much. If they could come nearer uniformity in the matter of quantity of dress there would be much less of display of "temper" over matters of temperature.

COLOR AND COOLNESS

The color of a fabric has much to do with the feeling of warmth or coolness observed by its wearer, particularly when under the influence of radiant heat, as from the sun, a stove, radiator or other heated body. Heat rays, like light rays, are largely reflected by polished surfaces, reflected in large part by white surfaces and light colors, and practically totally absorbed by black. Who has not noticed how much warmer dark, particularly black, clothing seems when worn in direct sunlight, as compared with light-colored, particularly white, clothing of even a heavier texture? The same is true as to the direct heat from a radiating object like a stove or radiator. Handlers of light petroleums and petroleum products, like gasoline, benzine and kindred substances, have long been aware of the fact that they could cut down losses from evaporation from storage tanks by painting them white, or with aluminum paint; while those in charge of keeping open the highways of some of our western states have learned that they can hasten the melting of snow by scattering soot, ashes or other black or dark materials over the surface. In the well-known thermos bottle and similar devices one of the methods for preventing interchange of heat and cold between the inside and the outside is to coat the inner walls of the double-walled glass container with a silvery deposit, which serves to reflect outside heat rays away and inside heat rays into the contents of the containers. In sunny weather white not only looks cooler than dark colors but actually is cooler on the under side—the side away from the sun. White tents, white houses, white shoes, white clothes, all other things being equal, are cooler than those of colors, particularly if the color be dark.

It would seem that—

(a) to keep cool while directly exposed to the sun's rays in summer, or to the rays from some source of radiant heat, one should wear black undergarments to absorb the heat rays from the body and white outer garments to reflect away the rays from sun or heat-radiating body.

(b) to keep warm while directly exposed to the sun's rays in winter one should wear white undergarments to throw body heat rays back to the body and black outer garments to absorb the few heat rays from the sun. However, the heat rays from the sun on a cold winter day are practically negligible, so the matter of color of outer garments would seem to be a matter of indifference, at least insofar as it has much influence on the warmth of these garments. Animals in cold climates, particularly in sections near the poles, are often white. This has usually been considered nature's way of protecting the animal from attack by other animals, the white of his fur making him invisible, or nearly so, against the white background of the snow and ice of these regions. I am wondering whether the Creator may not have had another purpose in mind when he created the first pair of polar bears, for instance. Within the polar circles there is much sunlight during about half of the year, and but little during the other half; and when the sun does shine it shines intensively. The polar bear, with no shade from trees to protect him, would get exceedingly warm if his coat were black or dark, but with a white fur to reflect the sun's rays he can be quite comfortable with only the heat of his body to partly dissipate; in winter the white fur conserves body heat and there is no external heat. He has no extremes to cope with—the heat that he needs is all furnished by his body.

The nature of man's skin is such that it is not a hot state of air that the naked skin has to fear, but rather the beating against it of energy of one kind and another. In the tropics where clothing is not needed for warmth civilized man protects himself against direct rays from the sun with umbrella, pith helmet, and white cotton or pongee clothing, while the savage keeps himself in the dense shade of the vegetation of those sections. Every year thousands of people in our own part of the world pay the penalty of suffering severe burns through being ignorant of the fact (or indifferent to it) that the sun's rays are more than heat-producing or light-producing. A day on the beach at the seashore is quite sufficient to remind them of the fact, or teach it to them if they did not know it before. Nor is it

sufficient to protect one's person against direct rays. Rays reflected from the surface of water also produce sunburn.

The answer to the question "What Shall I Wear?" is largely dependent upon what I am eating. If my diet is made up largely of heat-producing foods, like meats, sugary and starchy foods, I shall need fewer clothes to conserve body heat—I shall be producing more heat and I can afford to lose it faster without discomfort. If I try to live on lettuce sandwiches, spinach, and other substances which are largely water, I shall have to wear more clothes or suffer from cold in the winter. In hot weather we are advised to shun the use of large quantities of heat-producing food, if we would be comfortable. There is a definite relationship between one's diet and his raiment. There are people who would like to do away with eating and spend all their earnings on clothing; there are others who would go without clothes in order to keep their stomachs full: but we dare not go to either extreme. The more nearly we can come to maintaining the proper balance the more comfortable we will be. Willy-nilly, we must contribute to the living of both the food purveyor and the fabric manufacturer.

CLOTHES AND DIET

The more we exercise our muscles the less clothing we need, as under the action of our muscles a large amount of heat is brought to the surface of the skin, and this must be dissipated, else the body will become overheated, and serious results may eventuate.

An important function of underclothing is that of absorbing body excretions (perspiration, etc.). The average adult disposes of about 25 ounces of water, besides oil and other matter, through his skin every day, and provision should be made for their disposal in some manner. Were water the only substance eliminated it would be quite sufficient to allow it to evaporate. In its evaporation heat is taken up from surrounding objects (the body, clothing, air, etc.) and a sense of coolness (often actual cold) is experienced. The more rapid the evaporation the lower the temperature produced. The air in a "draught" is no colder than other air in the neighborhood (try it with a thermometer), but, because it is in motion, it hastens evaporation of perspiration, with its attendant absorption of heat (production of cold). Clothing which retards evaporation is needed where one has to be in draughty places. Because of the other substances excreted by the skin, underclothing should be of an absorbent nature and easily laundered, while the outer clothing should be de-

pended upon for warmth. Wool is highly absorbent, as are also cotton and linen. Linen is perhaps the most rapid in its action, but it dries more rapidly than the others, which accounts for its decidedly cold "feel" when next the skin. Knitted fabrics seem to be more absorbent than woven ones and have a less "clammy feel" ordinarily; as a rule they are easily laundered. They conform more easily to the form of the various parts of the body, hence absorb excretions more evenly. Sleeeveless and knee-length underwear is less sanitary than full-length clothing, unless our outer garments are equally attenuated. The body excretions which should be absorbed by the underclothing often go into the linings and fabric of the outer garments, which are not generally cleansed as frequently as is underwear. Someone has examined the sweatband of a hat that had been worn for some time and has found a large number of different kinds of micro-organisms making their home on it. What must be the number of such "bugs" that live in the fabric of the suit that a man has worn, without cleaning, for several years, particularly if the wearer wore but little in the way of underclothing?

What shall I wear for cleanliness? Yes, one function of clothing is to protect the body from dirt, both living and dead. The answer would seem to depend upon the nature of the dirt. If in the form of dust (finely divided dry matter) the outer garment should be as near non-porous as possible, to prevent the particles from passing through, and as smooth as possible to prevent the matter from adhering to it. If the dirt be of moist or greasy character the fabric should be one which absorbs readily, yet lends itself to easy cleaning at frequent intervals. If the dirt is living matter and a possible source of disease the fabric of the outer garment should be one that will stand boiling with water, or steaming for sterilization (cotton, linen or other cellulose fabrics). These factors are all recognized in the garments of nurses and physicians, particularly in hospitals.

What shall I wear for protection against mechanical injury? An important function of clothing is as a protection against bodily injury from rough surfaces, sharp points or edges, etc. The soles of our shoes are primarily for this purpose, and because of the roughness of the surfaces that our feet have to tread upon much of the time these soles have to be made of materials that have strong wearing properties. Leather, wood, rubber and rubber substitutes possess these properties to a considerable degree, hence their use in shoe manufacture. Protection of the hands against injury has not been

practiced as long as foot protection. The writer can remember when the baseball player who wore a glove was a "sis," even the catcher on a team not being allowed to wear more than one thickness of leather in the palm of one hand. Bricklayers, stone masons, carpenters, and others who had to handle rough materials could not wear gloves (except in winter when they were supposed to be worn only for warmth) without being subject to uncomplimentary remarks from their fellows as to their "softness." Time was when the man whose business called him into places where poisonous snakes might lurk carried his protection in a bottle. Today he wears his protection on the outside of his legs in the form of clothing of one kind or another, made of some material which is proof against the penetrating effect of the serpent's fangs. Leather, artificial leather, rubber-treated fabrics, strong cotton or linen fabrics lend themselves particularly to protection against outside injuries.

What shall I wear to keep me dry in stormy weather? Ordinary untreated fabrics are wetted by water. To make them shed water they may be treated with something which prevents them from being wetted. Rubber has been much used, but it has the disadvantage of completely closing the pores of the fabric to which it is applied, and making garments uncomfortably hot. Greases and oils have been used. Aluminum hydroxide and other substances are sometimes precipitated on the fiber, and make the fabric shed water quite effectively without losing its porosity, a desirable feature, particularly in warm weather. Where the fiber does not become wetted water falling upon it is collected into droplets which easily run off, while with fabrics which wet easily the water passes through easily.

I am working with alkaline materials, perhaps in a soap factory, or with mortar, plaster, or cement. What shall I wear? Wool is easily attacked by alkali and alkaline substances, particularly when wet, so the worker with such materials should wear cotton, linen or other fabrics made of cellulose.

I am working with acid materials. What shall I wear? Cotton, linen and kindred fabrics are easily attacked by acids, while wool is not attacked, except by very concentrated solutions; so, ordinarily, woolen garments are to be preferred for the clothing of workers with acids.

What shall I wear for endurance? Since beginning the composition of this paper one of my colleagues called my attention to two newspaper accounts that indicate that at least two persons have found

materials that have proved practically indestructible as garment-making cloth. One man in Vermont is said to have been wearing a pair of pants for 57 years. Notice that I said "pants," as we are not sure that the word "trousers" has been in existence that long. Another man 85 years old is said to have worn the same shirt for 75 years. He could not have grown as much between the ages of ten and eighteen, nor filled out in girth as much in the first thirty years of his manhood, as did the speaker, or else his parents, suspecting the enduring qualities of the material in the shirt, must have seen to it that the shirt was a number of sizes too big for him when they gave it to him. Possibly it fitted him at first about as much as do the clothes of a famous "star" on the comic screen—anything but "like the paper on the wall." Presumably the manufacturers of shirtings and trouserings have long since "bought off" these two men, so it will be impossible to tell you what the goods were and where they were purchased. It would be interesting to know what has been the occupation of these men, and how frequently the garments have been washed. Ordinary laundry practice could be expected to "finish" any fabric in far less time than has elapsed since these fabrics were made. The man with the long-lived trousers certainly could not have had a job which required him to sit at his work; indeed, he must have taken most of his meals standing.

The strength and wearing properties of fabrics are dependent upon several factors. All other things being equal the strength of a thread depends upon the length of the fibers of which it is composed, and, of course, the strength of a fabric depends mainly upon the strength of the threads composing it. Short staple cotton produces a weak thread, long staple cotton a stronger one, and rayon (which is made of very long fibers) a still stronger one. Much of the strength of linen is due to the thread being made of long fibers twisted together. With long-fiber threads the strength is due to the strength of the individual fibers; with short-fiber threads the weakness is due to the ease with which the short fibers slide upon one another and simply pull apart without breaking. With wool the barbed surfaces of the fiber causes thread to hold together better than those of cotton or linen, hence quite strong yarns can be made from short fiber wool. While dry rayon is quite strong, largely because of its long fiber, wet rayon is rather weak, so it has to be handled more carefully in the laundry than cotton or linen.

The clock tells me that the time allotted for this talk is gone, yet but little has been said as compared with what might be said on the subject.

"What Shall I Wear?" is the question asked by—

a. The woman who is invited to attend a social function;

b. The man and woman who are about to tour through the mountains;

c. The person who expects to cross the ocean;

d. The man who is about to take an aeroplane trip;

e. The party who is going to the seashore;

f. The youngster who is going on a camping trip;

g. The laborer in some industrial plant;

h. The long-distance swimmer.

The eternal question is "What Shall I Wear?", and the answer is "It All Depends."

WHY THE WEATHER

By George Rosengarten, Ph. D.

Assistant Professor of Physics at the Philadelphia College of Pharmacy and Science

"THE WEATHER for tomorrow will probably be fair."

So says the weather man and we make extensive preparations for the morrow only to find them spoiled by rain. This is all the more reason why we should make every effort to study "Why the Weather" in order that we may be able to predict with greater certainty the changes which may be expected.

George Rosengarten, Ph. D.

We shall turn back the hands of time to the very beginning of things when probably a passing star separated our solar system from the parent mass of nebulous matter. All the elements which now form the body of our earth must have been present in that original mass. As this mass began to cool a crust formed on the surface leaving some of the lighter elements still in the gaseous condition to form our atmosphere.

It is in this comparatively thin layer of gas, probably not more than 150 miles in thickness, that all the phenomena of the weather take place. The gravitating effect of the earth holds this gaseous envelope intact, although we are perhaps losing small amounts of the lighter gases hydrogen and helium at the extreme upper limit of the atmosphere.

Most of us are acquainted with the weather conditions for a very limited region and have left it to the meteorologist to study the weather while we merely talk about it. "Nice day" is our salutation or "It looks like rain." I purpose to bring to your attention some of the information which has been collected regarding this important problem and I feel certain we are all willing to learn more about the "Why of the Weather."

LOOKS LIKE RAIN

Man in his effort to understand the weather has penetrated the

atmosphere to a height of 7 miles in an airplane. He has sent up balloons carrying automatic recording devices to a height of 22 miles, beyond this his information is obtained from meteors and auroras. Modern means of transportation and radio communication have enabled him to cover all parts of the earth from pole to pole in the study and observation of the weather.

What do we find the main cause of the disturbance of this atmosphere? Our investigations point to the sun, at a distance of 93,000,000 miles out in space, as the prime cause of the weather. Here is what remains of the original mass of gaseous matter still at a temperature of 12,000 degrees Fahrenheit and sending out radiation at the rate of 250 million tons per minute. Passing through space this energy makes itself manifest wherever it falls upon matter. A portion of this energy falling upon the moon is reflected back to us as light. A larger amount reaches our upper atmosphere and penetrates to the earth producing the many varieties of weather which we experience. The greater portion is directed into space where all is dark and cold for there is no matter to absorb this radiant energy.

At the time of a total eclipse we can get some idea of the magnitude of the activity at the surface of the sun. Brilliant streamers extend for millions of miles in all directions about the sun. In this atmosphere about the sun many of the elements which form the earth have been found to exist in the gaseous state because of the high temperature. Of the radiation from the sun reaching the upper atmosphere about 63 per cent. penetrates while the remainder is reflected back into space. One-half of the energy which penetrates the atmosphere is absorbed in the gases and water vapor of the air, the other half reaches the surface of the earth. The atmosphere therefore acts as a blanket protecting us from the radiation from the sun, for without the air the temperature upon the earth would be greatly increased. The effect of this absorption of energy is to produce heat in the same proportion as it is absorbed. The solid earth absorbs more energy, heats up quicker, than the water. Since this physical phenomena, the absorption of energy from the sun is to play such an important part in our study of the weather we shall investigate further.

What is matter? What is heat? These are closely related. Matter consists of molecules of very small size. These molecules are in motion. What we sense as heat is the energy of this molecular motion. The greater the activity of the molecules the hotter the

body becomes. In the absence of matter heat cannot exist. This is the condition of space outside the atmosphere.

Every body radiates energy, the amount depending upon the temperature. This may be detected by the use of a radiometer which consists of a carefully mounted axle carrying 4 small pieces of mica on radiating arms and placed in a glass globe from which the air is partly exhausted. An electric light or any other heated body in the neighborhood of the radiometer will start it rotating thus indicating the existence of the radiation. One side of the mica has been painted black and absorbs more energy in consequence of which it heats up quicker. The few air molecules still remaining in the tube will rebound from the heated surface. It is the reaction of these air molecules that causes the rotation. When the radiometer is exposed to the direct radiation of the sun the speed of rotation is greatly increased.

It is during the day that the earth and its atmosphere absorb energy from the sun and we have an increase in temperature. At night we are separated from the radiation of the sun and the atmosphere cools. Hot air is lighter than cold air. The hot air rises to higher levels while the cold air rushes in to take its place. The rising air expands with consequent cooling and in time returns to lower levels to complete the circulation of the atmosphere.

It is not quite so simple. The rotation of the earth has its effect upon this general circulation of the atmosphere. The hot air rising above the equatorial regions is deflected towards the right as it moves northward toward the poles. The colder air currents from the north moving in to take the place of the rising column of heated air is likewise deflected toward the right. The deflection in the southern hemisphere is reversed. This combined effect of the heating of the air and the rotation of the earth produces our so called trade winds which blow nearly constant from the east in the equatorial belt and from the west in the temperate zone.

Besides the rotation of the earth upon its axis producing the changes between day and night, there is the revolution of the earth in its orbit around the sun. If the axis of the earth were perpendicular to the plane of the orbit and this orbit a circle about the sun we should receive at all times the same amount of radiation every 24 hours. It would always be summer or always be winter depending upon the place upon the earth. To be surrounded by the intense heat of summer or the extreme cold of winter is not to be desired. How

is it then that we are so fortunate as to be able to enjoy the ever recurring periods of more moderate weather?

The astronomer has not failed to bring to our attention some important information which has a direct bearing upon the weather. The earth in its passage around the sun, like a good spinning top, keeps its axis in the same direction. This is not perpendicular to the path of the earth through space but is inclined at an angle of 23½ degrees. The inclination of the axis combined with the motion of the earth has much to do with the amount of radiation received from the sun. At the one extreme occurring about December 22 we have the shortest days and the longest nights. It is winter in the northern hemisphere and the amount of radiation from the sun is least at this time. We must not forget that the southern hemisphere is then in the midst of its summer and because the earth is somewhat nearer the sun their summer is hotter than ours. By March 21 the length of day and night have equalized and the spring has begun. With the lengthening of the day and therefore the period during which the northern hemisphere receives mode radiation from the sun the temperature of the air rises. On June 21 we have our longest day but it is sometime later before we have our hottest weather. It requires time for the earth and its atmosphere to heat up after the cooling of the previous winter. From June 21 to December 21 the days are getting shorter and the nights longer, the earth continually receiving less radiation. The inclination of the earth's axis has relieved us of much travelling in order to experience a change of weather. Instead the weather travels north and south while we sit and enjoy it, or should I say endure it?

SCIENTIFIC WEATHER PROPHETS

The prediction of the weather is a favorable topic with some people. Our government has thought it of sufficient importance to carefully observe and record the weather for over half a century and today has 200 stations at various points in the United States where weather observations are made daily. Each station is equipped for recording the temperature and pressure of the air, the direction and velocity of the wind, the amount of rain or snow. These and any other unusual observations are communicated twice daily to the central office in Washington to be tabulated and the weather prediction made. With the development of the means of communication these predictions are transmitted to all parts of the country and appear in the daily papers. Maps are prepared and sent to hundreds of thousands in time to use the information thus obtained.

How are weather observations made and what do they tell us? We live at the bottom of a vast ocean of air, 150 miles or more in depth. This produces upon the earth a pressure the same as if the earth were covered with water to a depth of 34 feet. The air pressure at sea level is equal to 15 pounds per square inch or about 1 ton per square foot. It is because our bodies are filled with air at the same pressure that we do not experience any difficulty. Slight variations in this pressure occur throughout the day and appear to have a very close relation to the changes in the weather.

The barometer is the instrument which indicates the changes in the pressure of the air and perhaps is not so familiar to you as the thermometer. If we fill a tube closed at one end with mercury and invert it in a basin the mercury will remain standing in the tube at a height of about 30 inches above the level of the mercury in the basin.

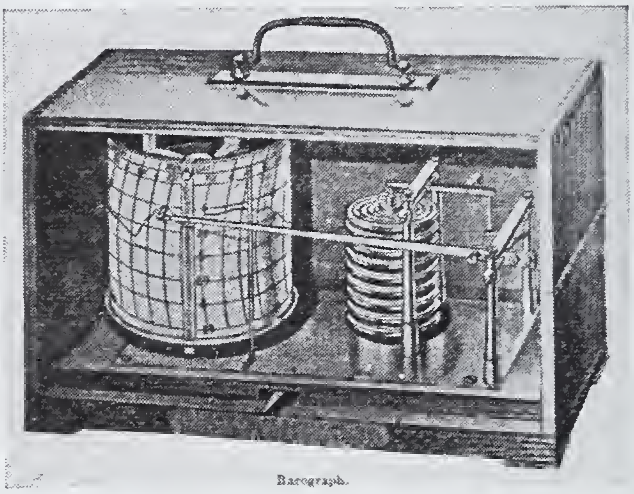


Fig. 1—Recording Barometer.

It is the pressure of the air that causes the mercury to stand within the closed tube. The height of the mercury is continually changing although the limits of the variation are quite small ranging from 28 to 30½ inches. So closely is our weather connected with the changes in the barometer than we can predict in advance the weather for the next 24 hours.

The aneroid barometer is a more convenient instrument for recording the changes in pressure of the atmosphere. With each variation in pressure a metal box is deformed and these changes communicated to an indicator which reads the corresponding height of the mercury column. Such an instrument would make a useful ornament in every household and much might be learned concerning the weather and its prediction.

Let us visit a weather station. In a well ventilated and covered

enclosure some distance above the ground the official thermometer is housed. In order to determine the temperature of the air the thermometer must be protected from the direct radiation of the sun and of nearby objects. In the direct path of the radiation the temperature of the ground may rise to 140 degrees while the temperature of the air some distance above is much lower.

To one side a small insignificant can, standing on several legs, serves as the rain gauge. It is important to know the amount of rainfall in a particular locality. In an agricultural region the total amount of rain throughout the year determines the nature of the crop. In the city where the ground has an artificial impervious covering a knowledge of the maximum rainfall to be expected determines the size of the drainage system necessary.

Much information concerning conditions in the upper air has been obtained by sending up kites and balloons carrying self-recording instruments. We not only find the oxygen content diminishing as we rise above the surface but there is also a decided fall in temperature. Temperatures as low as 90 degrees below zero have been recorded. It is this unequal heating of the air that produces the circulation of the atmosphere, the gentle breeze or the terrific hurricane.

The direction of the wind may be determined by the bending of the tree by the movement of the clouds or the smoke from a chimney. At the weather station a carefully balanced wind vane gives an indication at all times. Since local conditions greatly influence the direction of the wind the location of the wind vane is important. It is usually placed on the top of the building. We shall observe later that there is in general a close relation between the air pressure and the direction of the wind. Down by the sea we have the so called sea breeze during the day because the land heats quicker than the water. The heated air over the land area rises and the cooler air blows in from the sea. At night we have a land breeze because the land cools more quickly than the water. The direction of the surface wind is always from the cooler to the warmer region.

How strong is the wind? The speed of the wind no matter whether a gentle breeze or a hurricane is recorded by the anemometer cups whose rotation depends upon the velocity of the air. During the recent storm at Miami Beach the wind attained a velocity of 150 miles per hour.

The changes in the barometer are of such importance in weather prediction that a continuous record is desirable. This is obtained by

connecting the metal box of the barometer with a pen which moves up and down with each change in air pressure. (See Fig. 1.) A drum on which the record is made rotates beneath the pen thus causing an irregular line to be traced upon the paper and giving a record of the barometric pressure at any time of day or night.

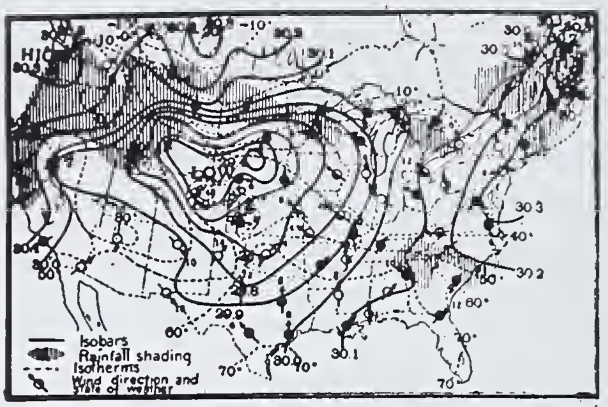


Fig. 16.—Weather map, 8 a. m., 75th meridian time, March 2, 1904, illustrating a LOW. Arrows fly with the wind. Figures at the arrow ends show wind velocities in miles per hour.

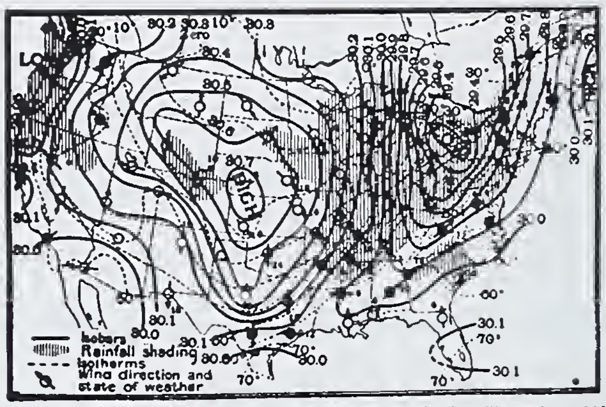


Fig. 17.—Weather map, 8 a. m., 75th meridian time, March 3, 1904, illustrating a LOW and the succeeding HIGH.

Fig. 2—Types of Weather Maps.

WEATHER MAPS

The weather map is a record of the simultaneous observations made at the weather stations through the United States. If we observe this record carefully we shall learn much concerning the "Why of the Weather" as it changes from day to day. The solid black lines, known as isobars, connect places having equal barometric pressure while the dotted lines or isotherms connect places of equal temperature. The isobars can be observed to inclose different regions upon the map, the so-called "Highs" and "Lows" or the places of high or low barometric pressure. The region about a low is known as a cyclone and the wind is generally toward the center and counter clockwise. In the anticyclone, the region about the high, the wind blows from the center and in a clockwise direction. We must not confuse these cyclones with the tornado or hurricane, for while the cyclone may cover a region 1500 miles in diameter the destructive tornado is much smaller, perhaps only 1000 feet in diameter.

A region of low pressure is usually connected with stormy weather while a high pressure is accompanied by clear weather. Let us follow the passage of a low moving from the west. The barometer begins to fall in advance of the storm center, the wind blowing from the southeast. Within a few hours the wind begins to shift now coming from the west as the storm center arrives with its rain or snow. With the passing of the storm center the barometer again begins to rise and the wind swings around to the northwest bringing with it a high. You can see how it is possible to predict the coming weather if these highs and lows should always travel the same path.

The cyclone moves slowly, about 2 to 8 miles per hour, from west to east, accompanied by the weather. A falling barometer indicates the approach of a storm center while a rising barometer is indicative of a return of fair weather.

The majority of lows which originate in the northwest pass across the northern part of the United States year after year. It is the approach of an unforseen low from the north or the south that in a way upsets our predictions.

Very different from these cyclones is the tornado. Advancing with terrific velocity the funnel shaped cloud extends toward the earth. The wind rotating counter clockwise leaves a path of ruin in its course. The width of such a storm may be only 1000 feet, no damage being done on either side. When such a storm passes out to sea a water spout is produced.

When the barometric pressure falls off very rapidly the storm is quite severe. Storms of this character originate southeast of the United States, and travel northwest crossing Florida and the Gulf States. Galveston, Texas, was visited by such a storm in September, 1900. Much property damage was done and 6000 persons lost their lives.

The summer of 1926 was marked by 8 or 9 such tropical storms, the one which is of especial interest occurred September 14-21. The storm was discovered in the West Indies as early as the 14th and news of the coming storm was published throughout the area. The storm center moved slowly northwestward, about 14 miles per hour, passed over the Bahamas on the 17th and reached Miami on the morning of the 18th. Early reports indicated a barometric pressure of less than 29 inches and a wind velocity of more than 100 miles per hour. An important feature of the hurricane is the relative calm which prevails at the center. Many persons thinking the storm had passed crowded

the streets to view the wreckage. After about 35 minutes the second phase of the storm arrived. Persons were knocked down and killed by flying timbers while others were washed out to sea in what was one of the worst storms that ever reached the United States.

WHAT IS THE CAUSE OF RAIN?

Many of the phenomena connected with the weather depend upon the amount of water vapor in the air. The heating effect of the radiation from the sun causes evaporation from the surface of the water. Some of the water molecules attain sufficient velocity to leave the surface and are carried upward by the rising air. The number of the mole-

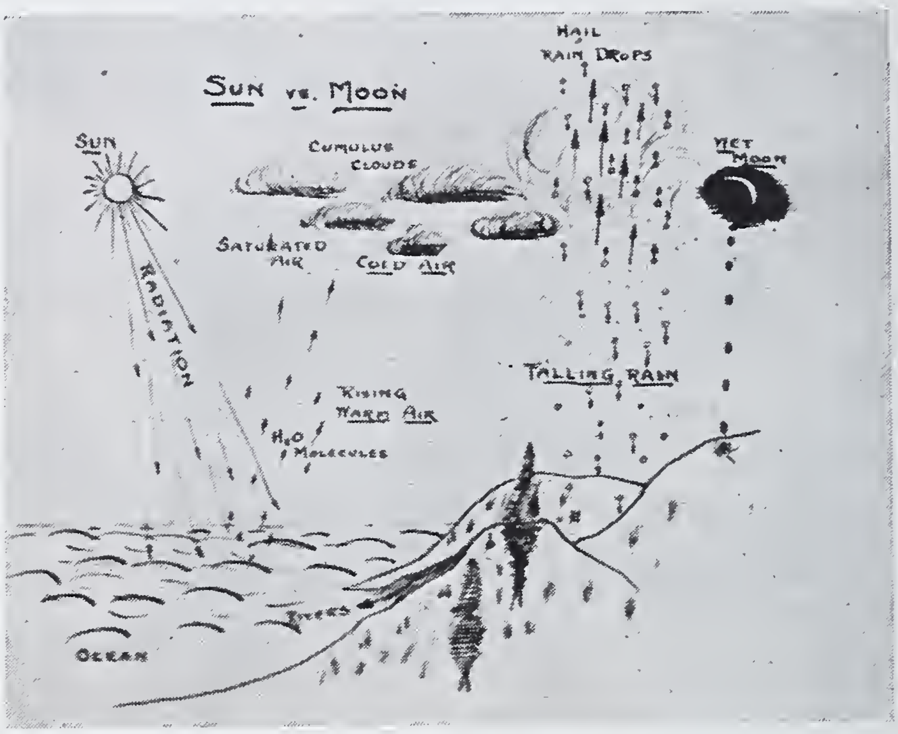


Fig. 3—Sun versus Moon.

cules of water vapor which the air can contain depends upon the temperature of the air. As the temperature of the air rises it is capable of holding a larger amount of water vapor before it becomes saturated. The temperatrue at which the saturation is reached is called the dew-point. The air in the room contains a certain amount of water vapor but at the temperature of the room the air is not saturated. On the outside surface of a pitcher of ice water we soon observe a condensation of the water vapor in the air. Upon the inside surface of the window we often find the water collecting. In both instances the temperature of the air has been reduced to the dew-point.

This phenomena is occurring in the atmosphere on a much larger scale at all times. When the air reaches the colder levels of the atmosphere the water vapor condenses as soon as the dew-point

is reached forming the clouds. The dust particles in the air play an important part in cloud formation. They form the *nuclei* upon which the water vapor condenses in minute droplets. The warm saturated air rising rapidly to higher levels finds fewer and fewer *nuclei* upon which to condense and consequently larger drops are formed. These fall and continue to grow in size until the up current of air is unable to support them. The return of the water in the form of rain completes the cycle which has been going on since the waters covered the earth.

Contrast this explanation with that of the old false weather proverb which placed the cause of the rain in the moon. When the horns of the moon dip downward the month will be wet and stormy because the moon will not hold water. When the horns of the moon are directed upward the month will be fair. Nonsense. "When the moon changes the weather will change" is another mistaken belief. The influence of the moon upon the earth is very slight. Its effect upon the ocean, producing the tides, has long been observed, but no relation exists between the changes of the moon and the changes in the weather.

HAVE WE ALWAYS HAD THE SAME KIND OF WEATHER?

We can always find some who are sure that the winters are not as cold as they used to be or it may be the reverse. The science of geology indicates that a number of decided changes have occurred in the past but not during the present generation. Periods of extreme heat followed by periods of extreme cold have taken place upon the earth and left their record in the rocks. It was during one of these periods that our coal beds were formed. At still another period the greater part of Canada and the northern part of the United States was covered by a thick layer of ice and snow. As the ice sheet retreated toward the poles the great lakes on our northern border were formed. Millions of years elapsed between these periods and we can only speculate upon the causes. In many instances these periods of extreme cold occurred at the time of mountain building. The elevation of large land masses, the extremes of volcanic activity pouring large quantities of dust into the upper atmosphere appear to be sufficient to account for the glacial ages of the past. There is no reason why these extreme changes of weather should not repeat themselves in the ages to come.

Many of the phenomena connected with the weather attract the attention. The clouds which float by in the setting sun produce one

of nature's beautiful pictures. Clouds are known by distinctive names. Those of the highest levels, the cirrus clouds, often appear like curling feathers or puffs of smoke. The very low temperatures of the upper atmosphere in which the cirrus cloud forms must indicate that they consist of ice needles or snow flakes.

When the cloud masses stretch out in a layer over a large area we call it a stratus cloud. A fog is nothing other than a cloud at the surface of the ground. A sudden cooling of the air causes the condensation of the water vapor on the dust particles in the air. If the surface of the ground is cooler than the air just above, the water vapor condenses in the form of dew or frost. In every instance we

Fig. 4—Cumulus Clouds. (Courtesy "National Geographic Magazine.")

have the air reaching the saturation point as the temperature falls to the dew point.

You, no doubt, have frequently observed the wave-like formation in the clouds stretching out across the sky in the so-called billow cloud. The wind blowing across the cloud mass stirs up a wave motion similar to that produced in a body of water.

As the warm air rising from the earth carries more and more water vapor aloft to be condensed in the colder regions above we find the familiar cumulus clouds forming. The base of the clouds present a flat surface indicating the stratum of lower temperature in which the cloud has formed. These cloud particles are extremely small, about 1/2500 inch in diameter.

At times the rising column of air causes considerable disturbance within the cloud. It begins to roll and turn. The lightning flashes and the thunder roars. The ancient Greek philosopher accounted for the thunder and the lightning by the bumping of these cloud masses. It was Benjamin Franklin who first brought down from these clouds a charge of electricity by means of his kite and key. How may the clouds become electrified? This has long been the subject of research. If drops of water fall through a stream of air of sufficient strength to break them apart we find the resulting drops are electrified. Now this is the condition in the atmosphere which accompanies the thunder storm. The rapidly rising column of saturated air penetrates the cumulus cloud producing the violent disturbance within the cloud. The rain drops formed in the cooler air are tossed about and broken up with consequent electrification. The formation of hail during the thunder storm is another indication of this phenomena. If we cut open a hailstone we find it to consist of successive layers of snow and ice formed as the hail was carried repeatedly to higher and colder regions until its weight could no longer be supported by the rising column of air. With condition just right the number of rain drops separated by the up current of air increases rapidly until the charge of electricity soon reaches a maximum.

The discharge of the electricity from one cloud mass to another or to the earth may well produce a feeling of fear and trembling for we know not where it will strike next. The lightning rod, the invention of Benjamin Franklin, has shown itself of value in protecting property from this natural force. But other dangers perhaps unseen lurk about us. The ordinary wire fence may carry the electric charge for long distances. The wire clothes line or the outside aerial form an easy path for the lightning. Photographs of the lightning have indicated many peculiarities. If the camera is rotating rapidly we find upon the plate not the single streak of lightning as seen by the eye but a succession of discharges, each one following the path of the former. The air through which the first discharge passes is ionized or electrified and thus forms a conducting path for the discharge which follows.

Another phenomena occurring in the upper atmosphere is the aurora. They appear in many forms and in different colors. Sometimes like a beam of light across the sky while at others like a flame of fire. At times the entire sky appears covered as if a curtain had

been let down from above. The exact nature of the aurora is not known but it appears to be electrical. We frequently have brilliant displays of the aurora at the time of sun spot maxima and perhaps is caused by electrical particles shot off from the sun.

The passing storm is often accompanied by the beautiful rainbow which very early drew the attention of man. We do not stand in awe today at the wonders produced by nature but seek a cause for each event. We have all observed the beautiful colors in the spray from the hose while attempting to assist nature in time of drought, or your attention has been called to the colors observed in the bevel glass and perhaps you gave little thought. In each case the band of colors is the same as observed in the rainbow appearing in the sky.

If we pass a beam of white light through a glass prism it is separated into different bands which diverge from the refracting surface and produce upon the eye the varying sense of color. Red, orange, yellow, green, blue, indigo and violet, each of a different wave length. It is the refraction of the sunlight within the rain drops that produces the beautiful rainbow.

I do not know whether you are a sun or a moon worshipper so far as the weather is concerned. I have endeavored to bring to your attention the facts as we have observed them. Form the habit of observing the weather and not merely talking about it. Do not be like the man who is sure the winters were not as cold as they used to be. We have developed considerable interest in the changes in temperature, the high points of the summer and the low values of the winter afford a never ending topic of conversation.

Why not the Highs and Lows of the barometer? Here is a chance to introduce a new thought in the conversation. "Nice day tomorrow, the barometer is rising" will add a bit of cheer to the friend you meet on a rainy day.

MOSSES AND THEIR MESSAGE

By Marin S. Dunn, Ph.D.

THE VEGETABLE kingdom may be divided into four great divisions. One of these divisions is the Bryophyta which comprises the liverworts (Hepaticæ) and the mosses (Musci). The believers in the old doctrine of spontaneous generation thought the mosses to be plants "originating in the putrefaction of other vegetables, or in the accidental concourse of generative particles, collected together by the alluvium of rains in rivers; and, consequently, as producing no flower or fruit." Now we no longer believe in spontaneous generation, and our knowledge of the structure, life, history and habits of various mosses is constantly being added to by the careful, thoughtful work of hundreds of nature lovers.

Marin S. Dunn, Ph. D.

Bryophytes may be recognized by the following characteristics: (1) They are generally terrestrial, (2) sexual and nonsexual individuals alternately give rise to each other, (3) the nonsexual plant is smaller than the sexual plant, (4) there are no true roots, but hair-like threads (rhizoids) are found on the sexual plants which have the functions of the roots of higher plants, (5) the female reproductive organ (archegonium) is a multicellular flask-shaped organ containing an egg, (6) the male organ (antheridium) is more or less stalked and consists of a layer of cells investing the sperm, (7) water is needed to accomplish fertilization since the sperm are of the swimming type.

Liverworts are of interest to us because they are "in-between" plants and may represent the transitional group between water and land plants. The members of this group are in general found in more moist localities than the musci and consist of rather flat, branching vegetative bodies (Fig. 1) or in some cases of leafy branches. Upon the upper surface of the plant, little cup-like structures may appear which contain within, special nonsexual reproductive cells called gemmæ (Fig. 2). Sex organs also may be present.

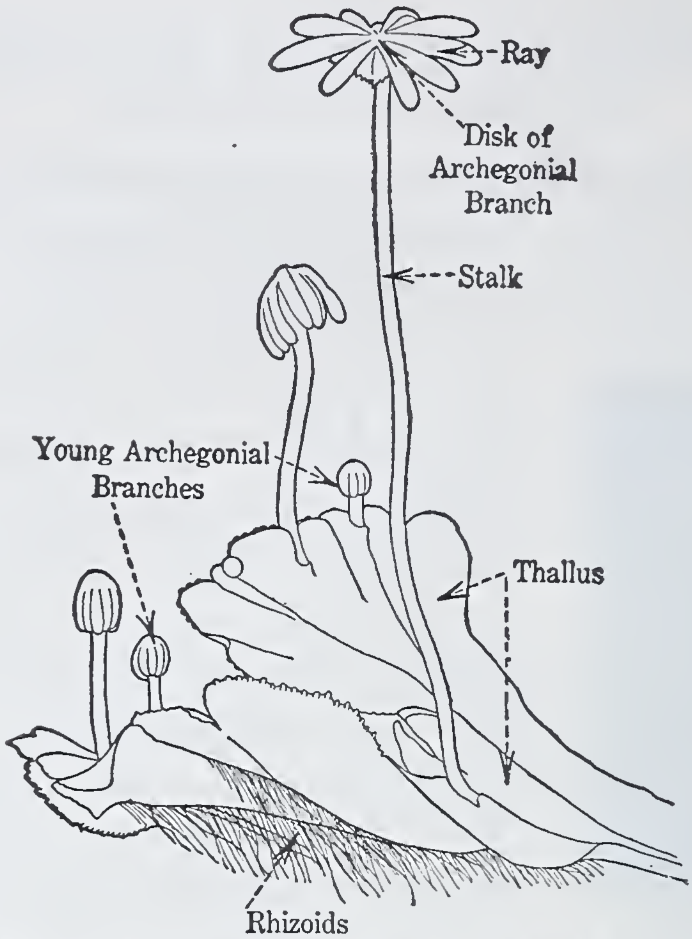


Fig. 1—A liverwort (Marchantia)—female plant. "Textbook of General Botany." Hollman & Robbins. (John Wiley & Sons, Publishers.) Reproduced with permission.

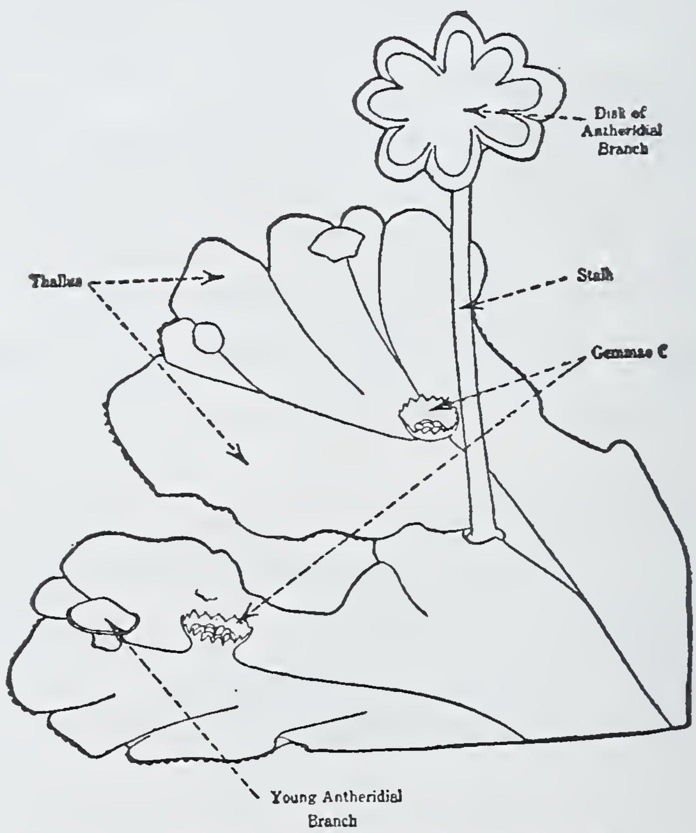


Fig. 2—A liverwort (Marchantia)—male plant. The little cups shown in the picture contain special non-sexual reproductive cells—gemmæ. "Textbook of General Botany." Hollman & Robbins. (John Wiley & Sons, Publishers.) Reproduced with permission.

On the other hand, mosses seem to have been derived from liverworts. Being widely distributed, they are found on trees, rocks, ground, and even in fresh water. They delight in the colder regions of the globe and are conspicuous in arctic and alpine flora. They are similar in many respects to the liverworts but in general differ from that group in the possession of a persistent more or less upright vegetative body differentiated into stem and simple leaves. The reproductive organs are found at the end of an axis of a shoot. In some cases, both types of sexual organs may be found on the same plant, while in others, the male and female plants may be separated (Fig. 6).

In the following paper, I shall dwell particularly upon the musci although it will be necessary in order to preserve continuity to touch at times upon certain phases concerning the liverworts. I shall not refer in this article, of course, to certain so-called mosses (Ceylon Moss, Club Moss, Corsican Moss, Golden Moss, Iceland Moss, Irish Moss, Pearl Moss, Spanish Moss, etc.) which, however, are not true Bryophytes but belong to different divisions of the plant kingdom.

Mosses may be divided into three orders. Of these only two—(1) the Sphagnales or Bog Mosses with the one genus—*Sphagnum* and (2) the Bryales or true mosses—hold our interest.

LIFE HISTORY

(1) Bog Mosses.

Sphagnum: The Bog Mosses are large pale plants which are found frequently in the swampy, humid parts of high latitudes where they may form peat (Fig. 3). They are abundant in Germany, Scotland and Ireland and in many places in the United States. Countless generations of plants go to make up the peat bog, and the Sphagnum is an important constituent of these plants. Upon draining the peat bog, desirable land for farming purposes is available. It has been estimated that one-fifth of the most fertile fields in Great Britain and Ireland have been obtained from bog districts through draining.

In the formation of a peat bog, the rapidly growing *Sphagnum* plants not only multiply along the borders of the pond or other body of water, but also grow out as a raft over the water. The submerged moss is continually dying and dropping and soil is thus always in the process of formation. The moss grows from the upper ends of its stem and certain branches. "The accumulation of vegetable matter attached to the living and floating plants on the under side causes the

raft to sink gradually; so gradually that the new growth always rests just at the surface of the water until the depth of the moss raft is sufficient to permit it to reach the bottom. In time, the weight of the superimposed moss, together with chemical changes which take place in the dead plant-tissue, convert the moss plants into more or less compact peat."

Thus a border of peat-moss soil is built around the shore; and as new plants are continually growing on the water-line, forming new rafts which in time sink and make new moss-soil, the body of water

Fig. 3—Bcg Moss—A leafy stem bearing a terminal cluster of Spore-containers. "Text-book of Botany." Coulter, Barnes & Cowles. (Amer. Book Co., Publishers.) Reproduced with permission.

becomes gradually less until finally it disappears altogether. During this process of marsh building a "quaking bog" occurs, when the moss covers the whole surface of the water but has not yet filled up the underlying water (Fig. 4). Both men and animals, while endeavoring to cross a "quaking bog," have sunk through the overlying moss to be entombed in the underlying peat; and, owing to the antiseptic quality of the peat, the bodies have been kept in a state of preservation for hundreds of years." (Marshall.[7])

Large bogs, often having an open lake in the center occur in

eastern and northeastern Germany. It was through one of the open bogs in Poland that a German officer gave orders that his men attack the retreating Russians, when practically the whole regiment sank out of sight.[5]

Sphagnum under the proper conditions grows with almost unbelievable rapidity. The following account is taken from Rhind's [8] "Vegetable Kingdom":

Ideal section of pond showing bog-moss growing outward from the shore.

Ideal section of old pond showing bog-moss growing on the surface of the water and forming a "quaking-bog."

Fig. 4—The Nature Library, Mosses and Lichens. Marshall, Doubleday, Page & Co., Publishers. Reprinted with permission.

"We learn from a paper in the Philosophical Transactions, that in the year 1651, when the Earl of Cromarty was nineteen years old, in travelling over the parish of Lochbrun he passed by a very high hill which rose in a gradual acclivity from the sea. At less than half a mile up from the sea there is a plain about half a mile in circumference, and from it the hill rises in a constant steepness for more than a mile in ascent. This little plain was at that time completely covered with a firm standing wood, which was so very old, that not only the trees had no green leaves, but the bark was quite thrown off, which the old countrymen, who were with his lordship, said was the universal manner in which fir woods terminated, and that in twenty or thirty years after, the trees would commonly cast themselves up from the roots, and so lie in heaps till the people cut and carried them away. About fifteen years afterwards, his lordship had occasion to come the same way, and observed that there was not a tree nor even a single root of all the old wood remaining; but instead of these, the whole bounds where the wood had stood was all

over a flat green ground, covered with a plain green moss. He was told that nobody had been at the trouble to carry away the trees, but that, being all overturned from their roots by the winds, the moisture from the high grounds stagnated among them, and they had in consequence been covered over by the green moss. The place was so soft and spongy, that his lordship in attempting to pass over, sunk up to the shoulders. Before the year 1699, (in the space of forty-eight years) the whole piece of ground was converted into a moss and the country people were digging peats out of it. At first they were soft and spongy, but gradually improved to the ordinary quality of peat."

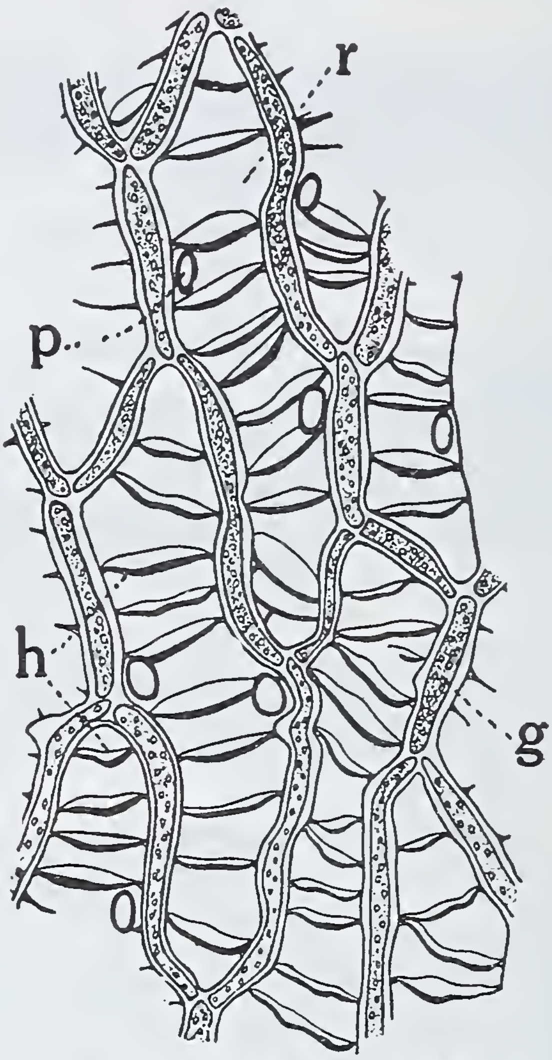


Fig. 5—Surface view of portion of a leaf of one of the bog-mosses showing water reservoir cells (r); transverse bands that prevent cells from collapsing (h); openings in reservoir cells (p); and green cells containing leaf-green (chlorophyll) (g). From "Pharmaceutical Botany." Youngken. Reproduced with permission.

Sphagnum plants are soft stemmed and weak. A transverse section of the leafy branch shows three regions, (1) cortex of empty cells like the large cells of the leaf, (2) elongated thick walled cells, (3) a pith-like center. The leaves are veinless and when examined under the microscope show two quite different types of cells (Fig. 5). The one is large, hyaline, perforated and strengthened by circular or

spiral thickenings; the other, smaller and containing chlorophyll (the green coloring material of leaves). When the plants are dry, the hyaline cells contain air and are collapsed but when moist or wet conditions occur, the large cells become reservoirs for water. It is obvious that the remarkable absorbing power of *Sphagnum* is due to this mechanism. It is this power of absorbing fluids that makes *Sphagnum* so valuable in compresses, pads, etc. (see later). The branches of *Sphagnum* are densely leafy and much branched, causing the formation of terminal tufts.

(2) True Mosses.

Let us follow the life history of a single, typical moss, the Haircap Moss, remembering that in the various orders of mosses certain variations in the following account may occur.

Most of us are acquainted with the tiny moss capsule. We have marvelled at its beauty and grace. Breaking it open, perhaps we have noticed the powdery material inside—the spores. These, in time, escape from the capsule, and if they fall upon damp soil with other conditions favorable, begin to sprout. There is formed a little green filament (protonema) which soon becomes branched. Hair-like threads begin to develop from its under surface and buds appear which develop into leafy stems which are so familiar to us under the name of "moss plants."

At the end of some of the leafy stems, female reproductive organs (archegonia) are formed and on others, male organs (antheridia). In the male reproductive organs are formed the spirally curved sperm cells each with two hairs (cilia). The female reproductive organs contain the eggs. In the presence of moisture, the sperm fitted for movement swim to the mouth of the female reproductive organs, attracted by some chemical stimulus, and fertilization thus may result.

The fertilized egg divides, and finally there is produced an elongated stalk bearing a capsule at its tip. The structure of the capsule to some extent is shown in Fig. 6. A part of the female reproductive organ is carried upward, on the top of the capsule and appears for a time as a little hat—the calyptra (Fig. 6). For a more complete description of the capsule, the reader is referred to "A Textbook of Botany" by Coulter, Barnes and Cowles. Inside the capsule, of course, the spores are produced which upon germination start the life cycle of the plant again. It is to be noted that the sexless

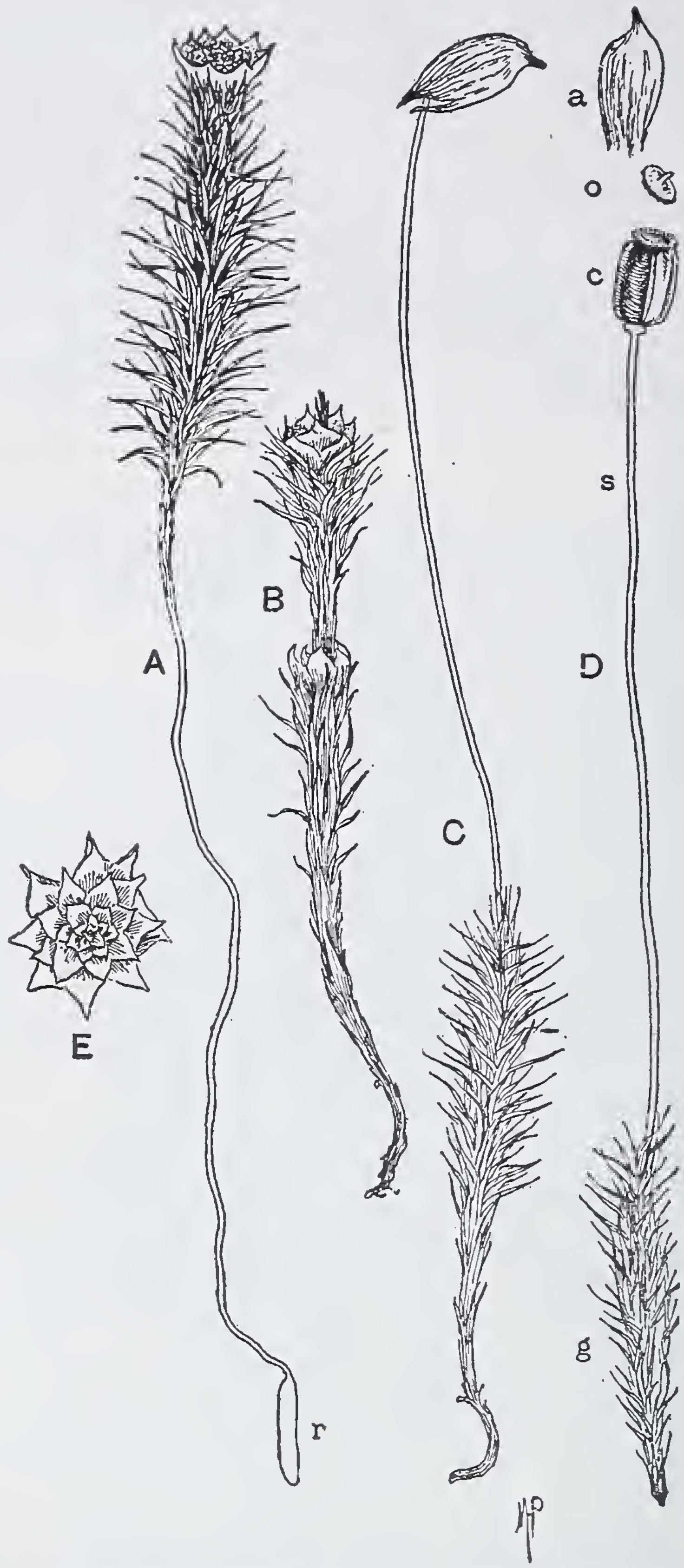


Fig. 6—Hair-cap moss (Polytrichum commune). A, male plant; B, same with new plant growing out from the tip of the older one; C, female plant bearing the capsule or spore-container at its tip; D, female plant showing the capsule (c) with the cap (a) removed; E, top view of male plant. From "Pharmaceutical Botany." Youngken. Reproduced with permission.

plant developing from the fertilized egg remains attached to the sexual plant, and that the sexual plant is the conspicuous, independent generation.

VEGETATIVE MULTIPLICATION.

Since the reproductive organs of mosses are borne on the summits of leafy branches, fertilization by swimming sperm is difficult and the power of vegetative propagation is accordingly greatly developed. Some of the ways are as follows: (1) the formation of special cells (gemmæ)—each gemma under appropriate conditions forming a new plant; (2) the older parts of the plant may die leaving isolated branches, which are capable of growth; (3) the production of resting buds; (4) the development of filaments from parts of the leafy branch or from parts of leaves; (5) the breaking up of the plant body is an important means in the case of *Ricciocarpus natans* (a liverwort).

Most of the work on mosses has been along lines of anatomy and classification. The investigations of the chemistry of liverworts and mosses have not been numerous.

CHEMISTRY

The constituents found have been in the nature of ethereal oils, resins, silicon salts, tannin, glucosides, alkaloids, certain organic acids and coloring compounds (Kræmer [6]). The moss cell membrane contains a certain percentage of cellulose, yet this is not directly recognizable by the use of the usual reagents (Czapek [2]). Sphagnol, of phenolic nature, has been found in the cell wall of *Sphagnum*. It also has been recorded in *Fontinalis, Trichocolea,* and is said to be generally distributed in mosses found in wet locations. Since it is a poison, the rôle of Sphagnol appears to be that of a protective agent. Moreover, certain iron-bluing substances which have been called by the long name Dicranumtannic acid have been found especially in xerophytic mosses such as *Grimmia, Barbula, Tortula, Orthotrichum, Dicranum, Leucobryum,* etc. Dicranumtannic acid is not as poisonous as Sphagnol.[2]

Let me point out that here is a fertile field which has scarcely been touched. Who may foretell what discoveries a thorough investigation of the chemical aspect of the moss problem may yield?

Those of you who are interested go through the literature for yourselves and see the sparsity of references dealing with moss chemistry. Compare with this the number of references you find of a purely descriptive and classifying nature. I am not trying to underestimate the value of the work of the morphologist and taxonomist as this is indeed essential. I am simply pointing out that we should do well to spend time in more thoroughly investigating the chemistry of the mosses.

Although we do not usually associate practical value with mosses, let us consider the uses which they may serve.

USES

Mosses are capable of making soil. Rock particles upon which they are growing are separated by mechanical pressure. As the living moss threads which ramify among these rock particles swell with water, tiny bits of rock may crumble here and there, loosened by the pressure. Mosses may also dissolve rocks chemically by the material secreted from their hair-like threads. All the while, the moss plants are growing larger and passing through their allotted span of life. In time, the older plants die, decay and crumble to mingle themselves with the rock débris upon which they grow. Add a certain amount of dust which has been caught by the plants. And we find that in a short time, an incredible amount of earth mould is formed which may furnish the soil necessary for higher mosses, ferns and flowering plants. Mosses, therefore, share with lichens the honor of being pioneers preparing the ground for that which is to come.

Certain aquatic mosses growing in streams have the power of catching the suspended mud and sand particles which are continually swept through them. There is gradually built up in the streams a foundation that other aquatic plants appearing later may use—various pond weeds, etc. These in turn dying may give place to generations of larger plants. Thus there is a plant succession, and the face of a given locality may in time change due to the blocking of outlets of ponds and damming of small streams.

Then, too, we must not forget that it is owing to the ability of the mossy floors of the forest in some mountainous regions to absorb large quantities of water that destructive floods and torrents are prevented from sweeping downward to the lowlands.

Certain mosses are instrumental in the formation of limestone. Let me quote from the excellent work of Marshall [7]:

> "In trickling springs of mountainous regions, and on the limestone rocks of Niagara Falls, and in other localities are found mosses which obtain part of the carbon dioxide (CO_2) they require by the decomposition of the bicarbonate of lime ($H_2Ca(CO_3)_2$) dissolved in the surrounding water. The monocarbonate of lime ($CaCO_3$), which is insoluble in ordinary water, is then precipitated in the form of incrustations upon the leaves and stems of the plants. *Gymnostomum curvirostre, Trichostomum tophaceum, Hypnum falcatum,* and others which regularly occur in streams arising from springs loaded with bicarbonate

of lime ($H_2Ca(CO_3)_2$) in solution become completely incrusted with lime, but go on growing at the tips as the older and lower parts imbedded in lime die off. In consequence, the bed of the stream itself becomes calcified and elevated, and, in the course of time, banks of calcareous tufa are formed, which may attain to considerable dimensions. Banks raised in this manner are known which are not less than forty-eight feet in height. To construct them, it is estimated the mosses must have been at work on them for more than 2000 years."

Mosses, often without sufficient reason, have been at different times variously used by man. Duchesne [3] in a work entitled "Repertoire des Plantes Utiles et des Plantes Veneneuses," published in 1836, lists among others the following:

Bryum triquetrum Turn.—employed as an astringent in hemorrhages.
Fontinalis anti-pyretica Linné—footbaths against fevers.
Funaria hygrometrica Hedw.—in cases of falling hair.
Hypnum crispum Linné—to pack and stuff the crevices of houses, to caulk ships, etc.
Polytrichum commune Linné—emmenagogue.
Tortula muralis Hedw.—as an astringent and has been used in cases of hemorrhages.
Sphagnum acutifolium Ehsh.—forms peat.
Marchantia chenopoda Linné, one of the liverworts—used in maladies of the liver—also cosmetic.
M. conica Linné—regarded as a refrigerative in Italy.
M. polymorpha—used in maladies of the liver.

Sphagnum in recent years because of its high absorbing powers has been given a great deal of attention. An excellent article upon this subject by J. W. Hotson [5] has appeared in the Bryologist. I am drawing largely upon this article in the following account. When the United States entered the world war, it found that surgical dressings made from *Sphagnum* were in general use in the British Army hospitals on practically all the Allied fronts. The value of *Sphagnum* was discovered, as far as the medical profession of Germany was concerned, by accident. Hotson relates the following:

"Prior to this discovery sphagnum, doubtless, was used locally as a dressing for wounds as it was in Scotland and Ireland, but its approval and sanction by members of the medical

profession was not established until the latter part of last century. It was Neuber, a surgeon at Kiel, in 1882, who published the following remarkable story.

"In the early eighties of last century a workman at one of the outlying peat moors in north Germany accidentally sustained a severe lacerated wound of the forearm. In the absence of anything better to apply to the wound, his fellow-workmen wrapped it up with fragments of peat which were lying near; and after an interval of ten days he arrived at the surgical clinic at Kiel with the original dressing undisturbed. It was feared that the wound when examined would be found in a very unsatisfactory state, but, on the contrary, when the peat dressing was removed, the wound was found to have healed in a most satisfactory manner. The unexpected result obtained with a dressing material which, at first sight, seemed so unpromising led to a very careful inquiry into its nature and properties.

"An investigation of the growing plant on the surface of the bog, down through the various stages of decay to the brown amorphous depths below, was made from the physical, chemical and bacteriological points of view. The practical outcome of this inquiry was that the value of sphagnum as a surgical dressing was found to be due to its marvellous power of absorbing fluids. It was found that the growing plant collected and dried had this power at the maximum, but the light brown layers of semi-decayed moss which lie above the peat proper retain great absorptive power also. It is probably, however, that it was from the partly decayed material that the temporary dressing just mentioned was taken.

"Thus, before the World War began, the value of sphagnum for surgical dressings was known to the majority of surgeons in Germany, although it was not used to any great extent until the war broke out. These facts were also known in a general way by the British and French surgeons, as well as to a few American surgeons."

Dressings and pads were of two kinds, those made of the loose moss and those of compressed moss. For a description of the making of these dressings, see Hotson.[5]

Some of the advantages which attend the use of *Sphagnum* are as follows:

(1) It is very highly absorptive. This is accomplished by the large empty cells of the stem and leaves (Fig. 5). Korach has shown that peat absorbs six times, wood pulp seven times, and *Sphagnum* ten times its dry weight of fluid. Other experiments show absorbent cotton absorbs from four to six times its dry weight

and *Sphagnum* as high as twenty times its dry weight. "Any moss absorbing ten times its weight or less was discarded by the American Red Cross. Not that this was unsuitable for dressings, but because sufficient material with an absorbency from sixteen to twenty was available."

(2) It is cool and soothing. The moss is so porous it dries quickly and this evaporation keeps the wound cool.

(3) It is cheap and abundant.

In addition to the uses already mentioned in this paper, *Sphagnum* is a good insulator, better than sawdust or cork. In Sweden, it is used to make certain coarse papers, such as wall-paper, wrapping paper and building paper. In Germany, a cloth is made by weaving a mixture of wool and *Sphagnum*. Of course, we have all heard about the rôle of *Sphagnum* in the formation of peat. It is of use to the nurseryman in packing plants, and certain orchilds grow well upon it.

CONCLUSION

In conclusion, allow me again to make the plea to our nature lovers to study mosses. There is no more fascinating field for quiet work and discovery. For those who enjoy grouping plants according to their relationships or who find pleasure in dissection, there are many problems of classification and structure. For the chemist and physiologist, the field for investigation is limitless.

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POPULAR SCIENCE LECTURES

Season of 1927-1928

To Be Delivered by Members of the Faculty of the Institution in One of the Auditoriums of the College Building at

PHILADELPHIA COLLEGE OF PHARMACY AND SCIENCE
145 North Tenth Street, Philadelphia, Pa.

All lectures begin at 8.15 P. M. and are of about one hour's duration. Admission is free and no tickets are required.

NOTE—About February 1 the College moves to its new building now in course of construction at Forty-third Street, Woodland and Kingsessing Avenues. The remaining lectures will be given at the new location. Previous announcement of this change will be made through the newspapers and to those who are on the mailing list of the College for individual notices of these lectures.

First Lecture Thursday Evening, October 13, 1927

THE "RARE ELEMENTS"

In Obscurity Yesterday—In the Spotlight Today

By Freeman P. Stroup, Ph. M.

Professor of Chemistry, Philadelphia College of Pharmacy and Science

A few months ago the civilized world was astonished more than ever before, even in this century of startling happenings, by the sudden jump of a youth from comparative obscurity to world-wide fame, through his making a "hop, skip and jump" from San Diego, California, to Paris, France. It is too early to predict accurately the major benefits that are to accrue to humanity through his "stunt."

Less startling, though hardly less amazing to those who have taken cognizance of them, have been the leaps of many so-called "rare elements" from obscurity into positions of great usefulness to mankind. Helium, long known to scientists but only recently to the layman; Radium, a "youngster" in the family of elements but a use-

ful servant of humanity, Tungsten, an aged member of the family who has but recently "found his stride" and serves millions as a "light-bearer" in electric light bulbs and a voice carrier in the radio "tube"; these and many others will be discussed by the lecturer in non-technical language that the "average" man, woman and child can understand. The lecture will be adequately illustrated.

Second Lecture Thursday Evening, October 27, 1927

FLAME

By George Wesley Perkins, B. Sc.

Assistant in Chemistry, Philadelphia College of Pharmacy and Science

Few characteristics distinguish man absolutely from the other higher animals, but the production and use of fire is one of these. So far as known no race of men has been ignorant of methods of making and using fire. The origin of the art is lost in the mist of antiquity. The Greeks sought to explain it by the myth of Prometheus.

A flame may be defined as the visible evidence of burning volatile matter. Its physical and chemical characteristics have been studied for many years. Some features are not yet clearly determined. Science has recently produced flames of hydrogen with a temperature approaching that of the sun.

The lecture will present the known data in regard to flame. Its many phases and practical applications will be illustrated by numerous experiments.

Third Lecture Thursday evening, November 10, 1927

ICE

By Paul Q. Card, B. Sc.

Instructor in Technical Chemistry, Philadelphia College of Pharmacy and Science

Glaciers are in continual formation and exercise their effects on the earth's surface. When close to the sea, they give rise to the hazardous iceberg that imperils shipping. Every child has been

thrilled with the sight of swirling snowflakes while his elders marvel at their fantastic and beautiful formation. The "Jack Frost" pictures on the window are of the same material that can break iron and move mountains. Men are trying to combat ice with "Thermite" when it becomes a menace. Ice is extensively used for refrigeration but is being replaced to some extent by "dry ice" or carbon dioxide snow and by modern electrical ice machines. There are many interesting scientific phases in the story of ice. The lecture will be illustrated with lantern slides and demonstrations.

Fourth Lecture Thursday Evening, December 1, 1927

BUILDING STONE, NATURAL AND ARTIFICIAL

By J. W. Sturmer, Ph. M., Phar. D.

Dean of Science, Philadelphia College of Pharmacy and Science

The story of natural building stones, used in the construction of Philadelphia's building; particularly, the story of Indiana limestone, Ohio sandstone, Vermont granite, New England marble, Pennsylvania slate. Also something of interest about artificial building stone, namely, mortar, plaster, cement, stucco, brick, terra cotta, floor tiles, etc.

Special reference will be made to the materials used in our new College Building.

Fifth Lecture Thursday Evening, December 15, 1927

WHAT AND WHERE ARE THE STARS?

By George Rosengarten, Ph. D.

Instructor in Physics, Philadephia College of Pharmacy and Science

The mystery of the past regarding the stars has been revealed. To the average man the stars are up in the air, but to the student of astronomy they have a greater significance. What has the astronomer discovered? How far has his photographic eye pierced the heavens in his search for truth?

The sun is our nearest star. Our observation of the sun and the stars leads to a better appreciation of the remarkable structure of the universe in which you live but form so small a part.

May we help you solve the mystery by presenting in a way you can understand this most fascinating subject: "What and Where are the Stars?"

The lecture will be illustrated.

Sixth Lecture Thursday Evening, January 5, 1928

THE REALM OF THE X-RAY

By Ivor Griffith, P. D., Ph. M.

Assistant Professor of Pharmacy, Philadelphia College of Pharmacy and Science, Professor of Organic Chemistry, Wagner Free Institute of Science

Invisible light. Spectres beyond the spectrum.

The discovery of the ray that penetrates.

Its applications in modern medicine and in industrial practices. The Coolidge Ray. The Death Ray.

An exhibit of X-Ray photographs and slides and apparatus will be presented.

Seventh Lecture Thursday Evening January 19, 1928

SOME QUESTIONS RELATING TO LIFE

By David Wilbur Horn, Ph. D.

Professor of Physics and Physical Chemistry, Philadelphia College of Pharmacy and Science, Professor of Inorganic Chemistry, Wagner Free Institute of Science

The fundamental problem of science is life. Any of its aspects, broadly speaking, is a complex matter involving physics, chemistry, biology and often other sciences as well. Each of these sciences is in detail so interesting that we must strive constantly not to lose sight of the fact that the fundamental problem is life. The present state of knowledge today is such that only preliminary questions relating to life can be attacked with any hope of success. But the popular discussion even of superficial questions on this subject is always interesting to many people and may open avenues for such individual consideration afterward as might prove fruitful.

The lecture will be illustrated.

Eighth Lecture Thursday Evening, February 2, 1928

THE ROMANCE OF COOKERY

By Charles H. LaWall, Ph. M., Sc. D.

Chemist to Food Bureau, Pennsylvania Department of Agriculture, Dean of Pharmacy, Philadelphia College of Pharmacy and Science

Burton said in the seventeenth century "Cookery is become an art, a noble science; cooks are gentlemen."

We do not know whether our troglodytic ancestors cooked their one-piece dinners or whether Charles Lamb's account of the origin of roast pig is the correct one, but we do know that the Greeks learned much about cookery from the Orientals and passed it on to our time through the Romans. Figures who stand out in this interesting story are Athenaeus, Lucullus, Heliogabalus, Catherine de Medici, Louis IV and Louis XV. It was during the time of the latter ruler of France that the *cordon bleu* came to be adopted as the insignia of the cook, the first to whom this decoration was granted being the cook of Madame du Barry. Down through the time of Brillat-Savarin to Delmonico of the generation just past runs the tale. What is the meaning of the expression "pot luck"? What is the origin of the word "mayonnaise"? Is the popularity of Dickens due to the fact that he devotes so much space to describing what his characters ate and drank?

The trail leads through the pages of ancient tomes whose recipes and menus tend to the belief that "there were giants in those days" in eating at least. Satisfy your longing for food before coming—no specimens will be distributed.

Ninth Lecture Thursday Evening, February 16, 1928

THE PRESERVATION OF FOOD

By Louis Gershenfeld, Ph. M., B. Sc., P. D.

Professor of Bacteriology and Hygiene, Philadelphia College of Pharmacy and Science

The relation to our health of a properly varied and abundant food supply is much discussed today. Transportation facilities have made possible the acquisition of a better quality and a greater variety

of foods. But this alone could not make possible the maintenance of a food supply sufficient to meet the demands of the normal increase in population. A factor of prime importance, which tends to make starvation less probable and a poor variety and quality of food less common, is the great development of the methods of food conservation. The scientific methods applied to the conservation and handling of food, which will be considered in this lecture, are: Frying and dehydration, smoking, salting, preservation by the aid of spices, condiments, vinegar and other acids, sugar and chemicals, canning and vacuum packing of foods, pasteurization and other processes employing heat, refrigeration, etc.

Tenth Lecture — Thursday Evening, March 1, 1928

EUROPEAN FLOWERS, AN IMPORTANT FACTOR IN CULTURE AND COMMERCE

By E. Fullerton Cook, P. D., Ph. M.

Professor of Operative Pharmacy and Director of Operative Pharmacy and Director of the Pharmaceutical Laboratory, Philadelphia College of Pharmacy and Science

The greatest reason for the culture of flowers in Europe and the world is the sheer aesthetic joy and delight they give to every class, age and condition of mankind.

The never tiring miracle of color, the wonder of perfume, the perfection and grace of form, all make this universal appeal.

That the flower quickly fades is accepted as one of nature's facts but the skill of the perfumer has in part overcome this by catching, and holding the fleeting esters distilled from the freshly opened petals, offering them for the gratification of later days.

Then too all of this beauty and its constituent force is not always lost when the flower fades, for the medical experience of past centuries has proven that in many instances the flowers possess healing virtues.

The traditions of the flowers are fascinating, the story of the part they play in everyday life of the people of Europe is interesting and many illustrations will add to the attractiveness of this presentation.

Eleventh Lecture Thursday Evening, March 15, 1928

SUMACH AND POISON IVY

By Horatio C. Wood, Jr., M. D.

Professor of Materia Medica, Philadelphia College of Pharmacy and Science

The various species of Rhus have found many uses in the arts, as lacquers and tannins, and also in medicine. Many of them are also of much interest because of their irritating effects on the skin. This lecture will describe the various uses of the different species and tell how to differentiate the poisonous ones, with some account of the symptoms and treatment of their toxic action.

Twelfth Lecture Thursday Evening, March 29, 1928

THE HEART

By Arno Viehoever, Ph. D.

Professor of Biology and Pharmacognosy and Director of the Botanical Gardens, Philadelphia College of Pharmacy and Science

The very seat of life and strength. Man's struggle to be master of his heart and that of other creatures presented in the treatment of (1) its structure, (2) its composition, (3) its function, (4) means to stimulate or depress its beat.

Moving pictures, lantern slides and exhibits of drugs and medicine used in heart disease will be part of the lecture.

Thirteenth Lecture Thursday Evening, April 12, 1928

ANIMALS THAT LIVE IN MAN

By Marin S. Dunn, Ph. D.

Assistant Professor of Botany, Philadelphia College of Pharmacy and Science

The subject of animals that dwell in man is ever fascinating and important. Here, among others, are found the malaria "germ," the hookworm, the tapeworm, the sleeping sickness organism and the animal producing trichinosis when insufficiently cooked meat from an infected pig is eaten.

The lecturer will choose certain forms of common interest and discuss them with respect to (1) the parasite, (2) the host or hosts, (3) methods of infection, (4) the disease produced, (5) cure, (6) prevention.

The lecture will be illustrated by charts, specimens and lantern slides.

WHAT IS THE PHILADELPHIA COLLEGE OF PHARMACY AND SCIENCE?

For 107 years the Philadelphia College of Pharmacy and Science has stood for what is best and highest in the practice of pharmacy. It is the oldest College of Pharmacy in America and one of the oldest in the world.

It was founded in 1821 and chartered and incorporated in 1922 as an institution of learning entitled to confer degrees in pharmacy. In 1918 its scope was enlarged and its charter amended so as to enable it to confer the B. Sc. Degree in Pharmacy, in Chemistry, in Bacteriology and in Pharmacognosy. In 1926 the State of Pennsylvania granted the college authority to confer the degree of Master of Science in the foregoing subjects.

It has never received aid from city, State or nation, but through the generosity of alumni and friends of educational progress it has developed into an institution of international fame. Many thousands of students from all parts of the world have taken its courses. A large number of its graduates have attained distinction in various fields of scientific work.

It now has more than 6000 alumni distributed in many States and foreign countries.

It is now constructing a modern building in West Philadelphia which has been made possible through a successful campaign for funds, begun in 1921.

The College possesses a valuable museum of pharmaceutical, chemical and drug specimens, and a library of about 20,000 volumes which has been generously endowed to ensure adequate growth and progress.

The library and museum, although primarily intended to serve the interest of pharmacy and the allied sciences, are open to the public from 9 to 5 excepting Saturdays and holidays.

The members of the faculty of the College have generously served the newspapers of the community, and the general public as well, in the dissemination of accurate scientific information upon a wide range of subjects.

Additional endowment is needed by the College for the development of scientific research along lines of benefit to mankind and in furtherance of its educational program.

Bequests, endowments or gifts of any kind are welcomed and will be devoted to the extension of the general public service rendered by the College or in specific accordance with the desire of the donor.

PUBLISHED VOLUMES OF POPULAR SCIENCE LECTURES

Following the second year of the presentation of these Popular Science Lectures by the Philadelphia College of Pharmacy and Science a demand arose for the lectures in book form, in spite of the fact that most of the lectures had appeared in the American Journal of Pharmacy following their presentation.

This demand has been supplied for the past four years and the following volumes with their lecture subjects are available at a cost of $1 per individual volume.

Volume I includes 12 lectures as follows: "Chemistry as an Aid in the Detection of Crime," "Corn and Its Products," "The Story of Glass," "Bacterial Preparations," "Another Drop of Blood," "The Romance of Spices," "Catalysis and Catalysts," "The Aluminum Age," "Animal Eating Plants," "Explosives and Explosions," "The Making of Medicines," "Iron and Iron Alloys."

Volume II includes 11 lectures as follows: "Invisible Light," "The Story of Rubber," "Chemistry In and About the Home," "Idiosyncrasies, or the Story of a Sneeze," "What is Chocolate?" "Sugar as a Medicine, Food and Poison," "Social Insects," "The Romance of Drugs," "Something About Gases," "Household Insect Pests," "Drugs of the North American Indians."

Volume III includes 13 lectures as follows: "Arctic and Tropical Pennsylvania," "The Romance of Chemistry," "Chemistry and Color," "The Mineral and Vegetable Resources of the Sea," "Chemistry In and About the Home," "The Ups and Downs of Nitrogen," "Animal Aviators," "Practical Disinfection," "Why Soap?" "What

Shall I Eat?" "Bridge Construction," "Chalk and Its Chemical Relatives," "Control of Growth in Plants and Animals."

Volume IV includes 12 lectures as follows: "The Romance of Medicine," "More About Color and Colors," "Coal and Coal Mining," "Environment—The Big Factor in Health and Disease," "Imitation of Life," "The Sign of the Skull and Cross Bones," "Delectable Confections," "The Flight of a Ball Through the Air," "The Diamond and Its Colored Brethren," "What Shall I Drink?" "The Salt of the Earth," "Abnormal Plant Growths."

Note.—The volumes of Popular Science Lectures are now published with the aid of a fund established for this purpose in memory of Mr. Thomas D. Simpson, of Philadelphia.